WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

UNIVERSITY MICROFILMS
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New Sewage Treatment Plant at Eugene, Oregon
See Page 461

Rubber-lining a Large Concrete Reservoir

Compressed Air In Water Pumping and Treatment

NOVEMBER 1955

IT'S NOT THE INITIAL COST

it's the upkeep...

Competitive bidding on water works projects has brought the price of comparable pipes of different specified materials to a nearly common level. Today, the important consideration for the buyer is not so much the first cost as the maintenance charges which continue throughout the life of the pipeline.

In any such comparison, the superiority of LOCK JOINT CONCRETE PRESSURE PIPE is demonstrated by the experience of hundreds of municipalities. One of the country's largest industrial cities, for example, reports that during 1954 NOT ONE CENT was spent for maintenance or repair of the more than 14,000,000 inch feet of Lock Joint Concrete Pressure Pipe in its water works system.

Your city, too, can virtually eliminate maintenance expense, and save many times the initial installation cost with Lock Joint Concrete Pressure Pipe.

LOCK JOINT PIPE CO.

East Orange, New Jersey

Sales Offices: Chicago, Ill. • Columbia, S. C. • Denver, Col. • Detroit, Mich.
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Pressure • Water • Sewer • **REINFORCED CONCRETE PIPE** • Culvert • Subaqueous

Save up to 60% of floor space

with

JOHNSTON Vertical Turbine PUMPS

and reduce maintenance and operating costs!

Here is why rugged, economical Johnston Vertical Turbine Pumps are used for municipal water supply by the City of South Gate, California and are preferred by experienced municipal engineers everywhere. Vertical design saves up to 60% of floor space. They fit in tight places where space is at a premium. No need for costly priming devices—Johnston Pumps can be installed to start and stop easily and require no priming. Low maintenance and operating costs—measured dollar for dollar per year of service, make Johnston Pumps the most economical you can buy. The Johnston dealer in your area will gladly confer with you on your pumping problems. Write for details.

JOHNSTON VERTICAL PUMPS

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Founded in 1909
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WSW-115

Reaction kettle for making ion exchange resins at The Permutit Co., Birmingham, N. J.

Why we make our own ion exchange resins:

First—in order to offer our customers the best resins.

But the main reason we make our own resins is that we can "tailor" their molecular design, chemical and physical characteristics to best meet process and equipment requirements. It gives us greater control of capacity, efficiency, stability and mesh size.

It also supplements our production of other types of zeolites with the result that Permutit (and only Permutit) makes all widely used types of ion exchangers . . . from rugged natural greensands for simple, low-cost water softening to specialized resins for purifying chemicals.

And it enables us to offer an integrated Water Conditioning Service including water analysis, engineering, equipment, controls and the ion exchange material itself . . . from one source . . . under one responsibility. That's how "weak links" can be avoided. That's why Permutit equipment gives long years of trouble-free service.

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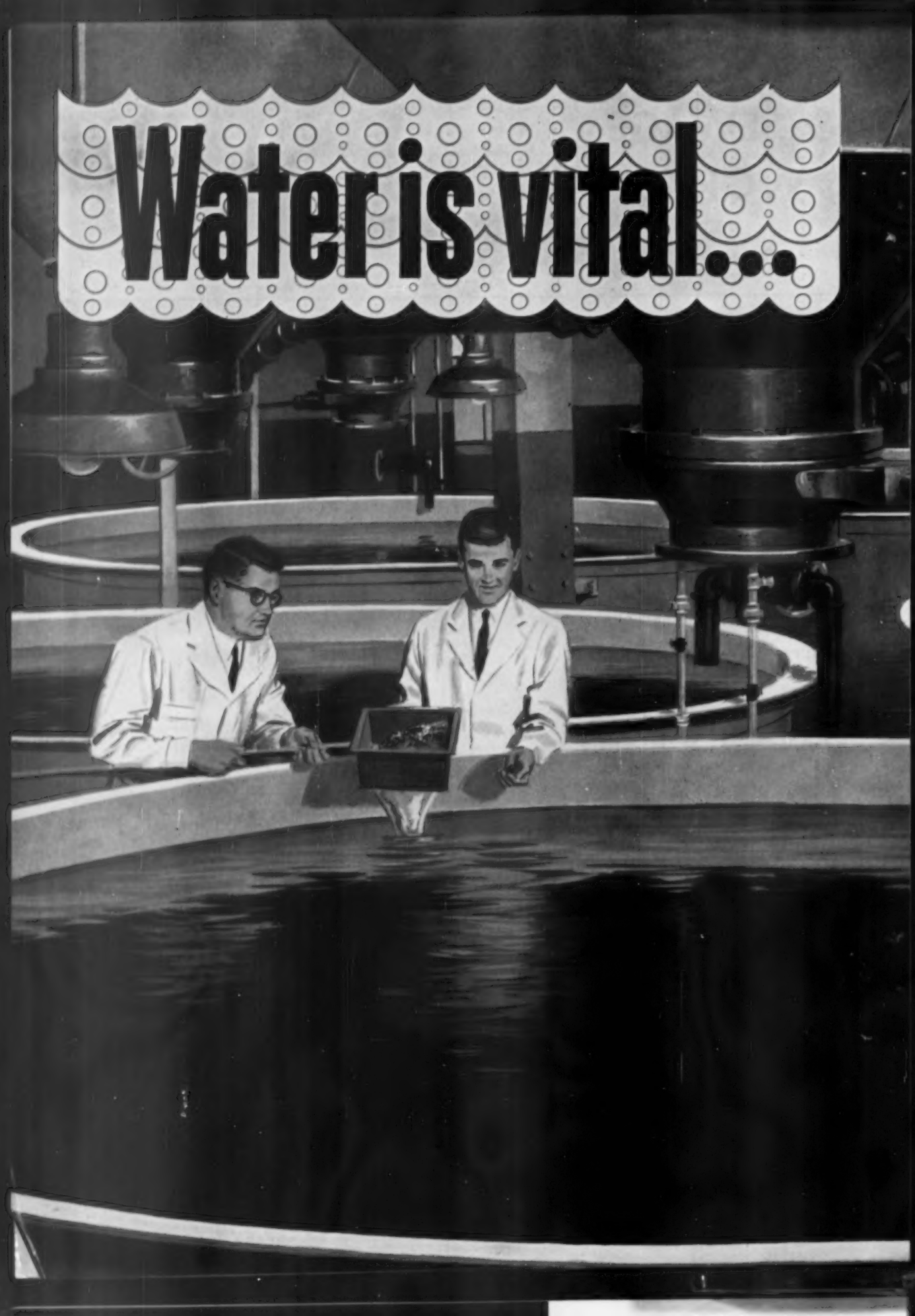
WATER AND SEWAGE WORKS is published monthly with an extra issue in June. Subscriptions including the Reference and Data issue in the U. S. and Canada, 1 year $3.00; 2 years $4.50; 3 years $6.00. Other countries $1.50 per year additional. Single copies 25¢ except Reference and Data issue 50¢.

WATER AND SEWAGE WORKS, Reg. U. S. Patent Off. Published monthly by Scranton Publishing Co., at 5th and Ferry St., Lafayette, Ind. Entered as second class matter at the post office at Lafayette, Ind., under Act of March 3, 1879.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Badger meters conserve it better!

THE malting industry uses nearly *3-billion gallons* of water per year to produce this taste-inviting ingredient for America's favorite beverages and foods. Actually, 35 times *more water than barley* is involved in the processing.

Badger water meters are a vital part of most large-volume processes — helping conserve water for America's growing industrial and residential needs. Accurate measurement provides a precise check on usage and waste . . . makes certain that users pay fairly for water consumed . . . helps make water departments self-supporting.

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Badger Water Meters

Badger Meter Mfg. Co.
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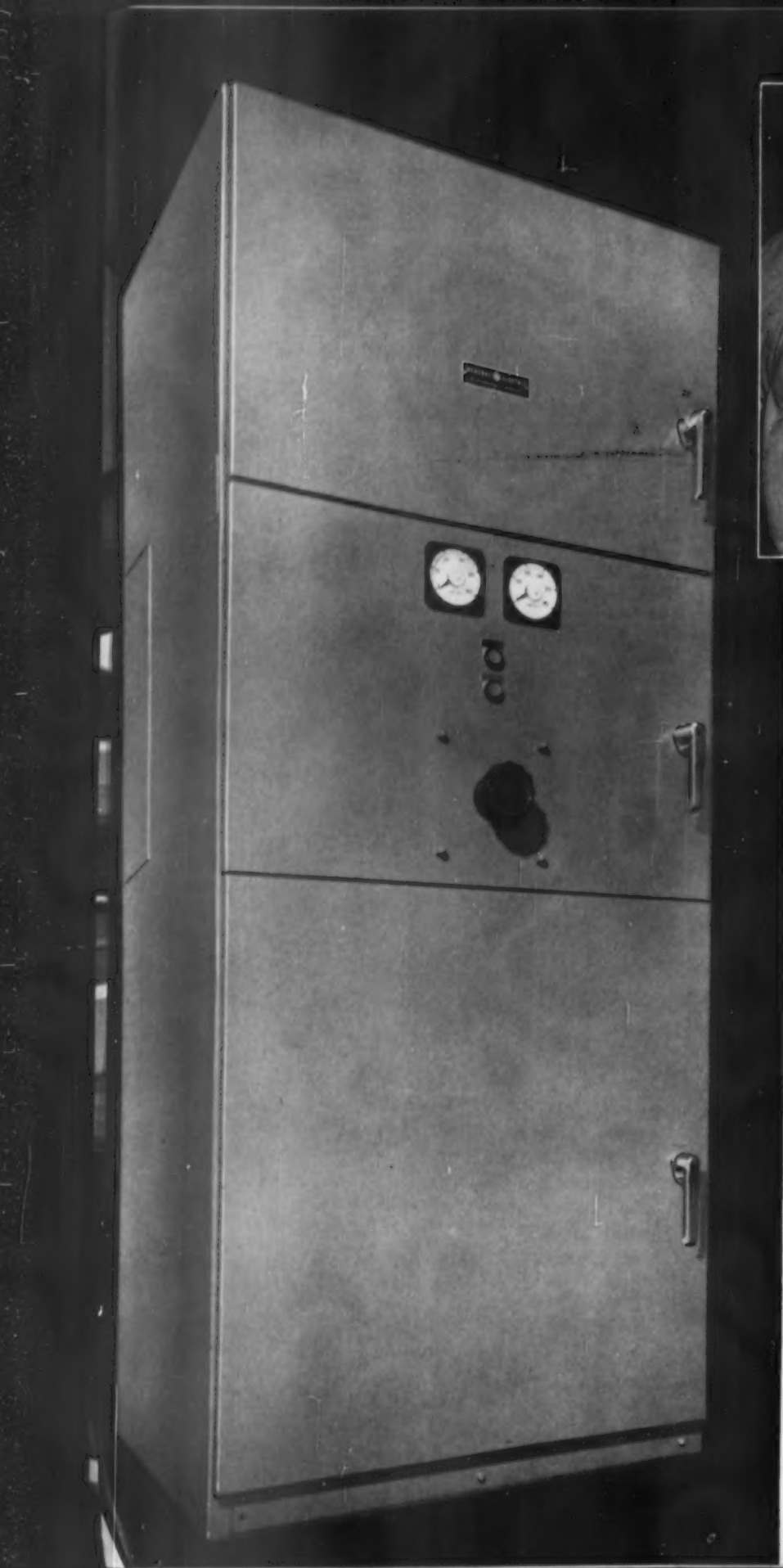


3 CUSTOMERS STATE . . .

Space, Safety

Placed on the market in July of this year, General Electric's all-new Limitamp Control has received enthusiastic acceptance throughout industry.

1. NEW MOUNTING ARRANGEMENTS. Almost immediately, L. L. Hamig, of Ferris & Hamig, Consulting Engineers, found the exclusive front-connected feature of the new control solved a tough application problem. There is no need for a back aisle with the new equipment, so units may be mounted back-to-back, back-to-wall, or as free standing enclosures yielding great space savings.

2. 50% SMALLER. In another case, H. A. Weigand, of Ingersoll Rand Company specified this new fused starter in a compressor station for the Laclede Gas Company of St. Louis, Missouri. Mr. Weigand stated the new control's 50% floor space saving feature simpli-

50% smaller than previous models, all-new G-E Limitamp Control offers a gang-operated disconnect switch as standard equipment. See opposite page for space savings comparisons.

"The all front-connected feature of G.E.'s Limitamp Control gave me the versatile floor arrangement I needed to solve a tough application problem," said Mr. L. L. Hamig (extreme left) of Ferris & Hamig, Consulting Engineers, St. Louis, Mo. Seated are R. E. Watts of Ferris & Hamig and P. L. Korkian, General Electric Co. Sales Engineer.

"The space savings offered by G.E.'s Limitamp Control helped simplify the installation of a compressor station for the Laclede Gas Co. of St. Louis," according to H. A. Weigand of Ingersoll Rand Company. The compressor station is located in a residential area and conforms to local building codes. This put space requirements at a premium and posed a real installation problem.

Problems Solved by New G-E Limitamp* Control

fied installation where space considerations were a primary factor.

3. ADDED SAFETY. One of the nation's largest automobile manufacturers ordered eight of the starters and within days increased the order to 17. The gang-operated disconnect switch and co-ordination features which afford greater protection of the starter, the controlled equipment, and personnel were exactly what they wanted.

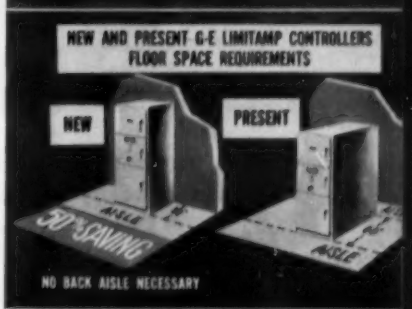
The 30" depth of the new Limitamp Control, which allows the unit to be transported through normal size doorways, has also received industry-wide approval. The unit's 90" height includes bus compartment which is surrounded by steel barriers within the enclosure.

Other features which save time and money on installation and maintenance are the low-voltage panel, hinged to swing out of the cabinet, and the contactor which may be easily rolled in or out of the enclosure. This provides ample room for a worker to enter the enclosure while making installation connections.

This all-new Limitamp Control is ideal for high-voltage motors, rated 2300-4800 volts, up to 3000 hp, and may be applied to squirrel-cage, synchronous, wound-rotor, and multi-speed motors on power systems requiring high interrupting capacity for maximum short-circuit protection.

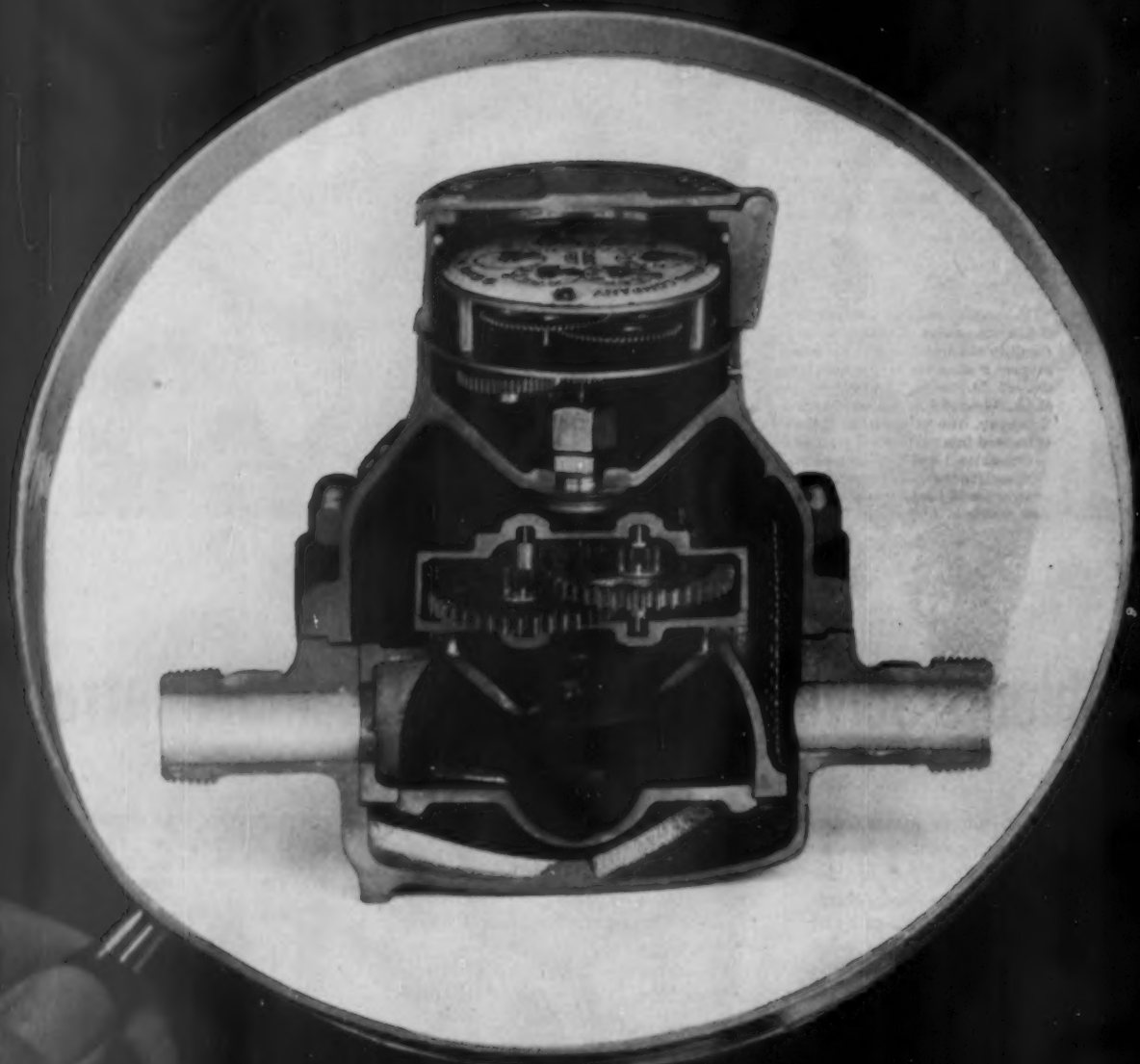
Specify the all-new Limitamp Control through your nearest G-E Apparatus Sales Office. G-E engineers will help apply this new control to your operation. For more information write for Bulletins GEA-6331, GED-2446, to Section 781-14, General Electric Company, Schenectady 5, New York.

*Trade-mark of General Electric Co.



Progress Is Our Most Important Product

GENERAL ELECTRIC



Close examination of the mechanical details proves beyond doubt the skill and fine workmanship that go into the making of every

HERSEY WATER METER

and the materials used are the best obtainable, based on sixty-nine years of meter building experience. RESULT: Last longer, operate more accurately and at a very low maintenance cost.

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FAMOUS LIGHTHOUSES OF AMERICA

STANNARD ROCK LIGHTHOUSE, Lake Superior, Michigan, is located about 23 miles southeast of Manitou Island. Completed in 1883, the stone tower is built on a base of concrete and stone which stands on solid rock in 11 feet of water. The light, 102 feet above water and visible for 18 miles, protects shipping in a dangerous area on the heavily traveled trade route between Duluth and the lower lakes.

Protection for the quality of your products and the efficiency of your processes is provided by the uniformly high standards of Niagara Alkali Company products. Depend on the purity and uniformity of Nialk® Liquid Chlorine, Nialk Caustic Potash, Nialk Carbonate of Potash, Nialk Paradichlorobenzene, Nialk Caustic Soda, Nialk TRICHLORethylene, Niagathal® (Tetrachloro Phthalic Anhydride).

NIAGARA ALKALI COMPANY

60 East 42nd Street

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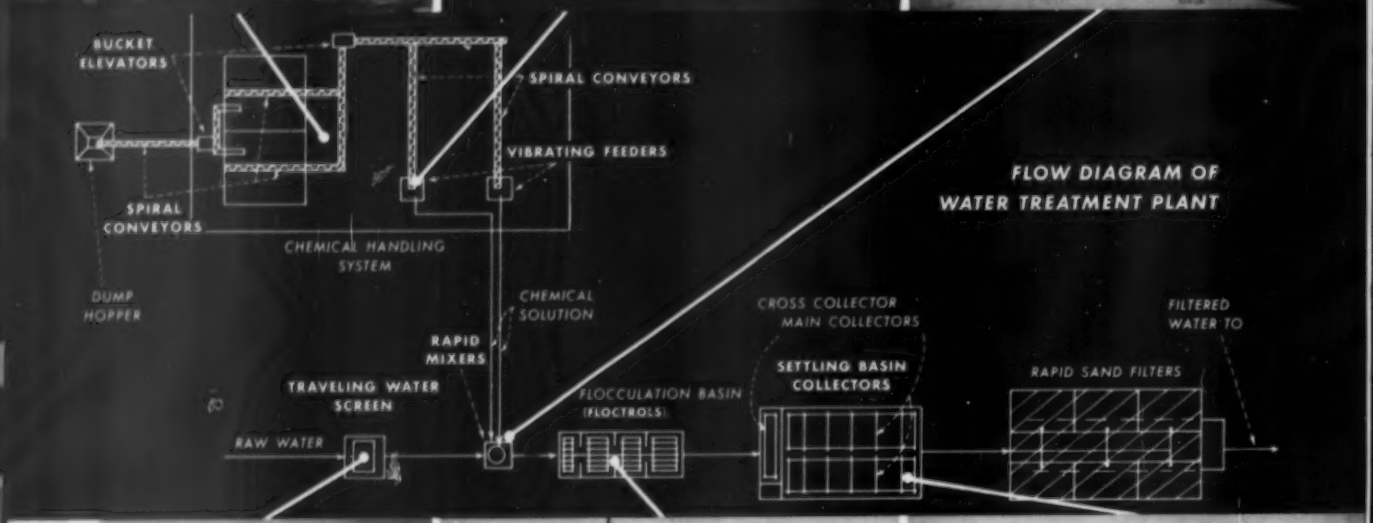
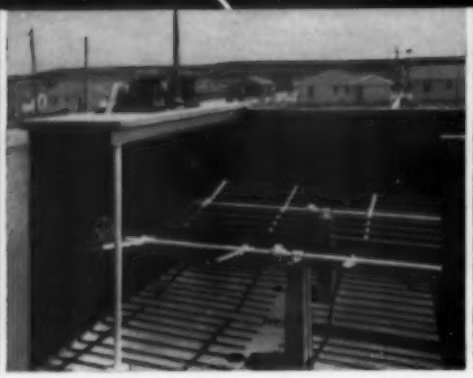
Bucket Elevators fill these storage bins. Spiral conveyors carry chemicals away.

Eight WAYTROLS here in this waterworks automatically proportion chemicals for mixing.

Mixers insure proper blending of coagulant solutions, assuring most economical use of chemicals.



Traveling Water Screens remove all floating debris and suspended matter from plant influent.



FLOCTROL tanks give complete flocculation in shortest possible time, with minimum chemical usage.

Sludge Collectors for settling basins are designed for quiescent flow to speed sedimentation.

let JEFFREY **MECHANIZE** your water treatment plant

JEFFREY's sixty-five years' experience with material-handling equipment qualifies the JEFFREY Sanitary Engineering Division to offer complete technical assistance on water treatment plant equipment and design. Catalog 833-A describes this equipment. The Jeffrey Manufacturing Company, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT • TRANSMISSION MACHINERY • CONTRACT MANUFACTURING

TAUNTON reports...

"Not a Service call in 2½ years"

These two Builders Model CVS Chlorinizers have been in service at the Taunton, Mass. Sewage Treatment Plant (designed and engineered by Fay, Spofford and Thorndike) since late 1949. Paul Manter, Chief Operator (shown in the photo) has nothing but praise for the Chlorinizers. During the past 2½ years, he reports there hasn't been a call for service of any kind on these machines. Mr. Manter now expects the Chlorinizers will give two to three times more effective service life than originally estimated.

This kind of performance explains why Builders Chlorinizers are gaining such wide acceptance for all types of chlorination assignments. Whatever control system you use . . . manual, program, semi-automatic, or flow-proportional . . Chlorinizer will save you money and simplify your operating problems. Write for bulletins giving complete details on the four basic models of Builders Chlorinizers. Builders-Providence, Inc., 350 Harris Ave., Providence 1, Rhode Island.

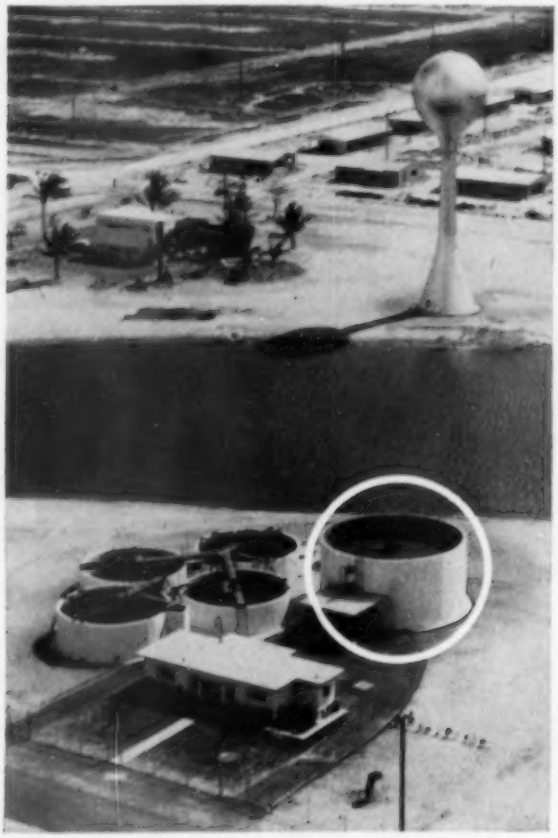
BUILDERS-PROVIDENCE

DIVISION OF B-I-F INDUSTRIES, INC.

BUILDERS IRON FOUNDRY • PROPORTIONEERS, INC. • OMEGA MACHINE CO.

B-I-F METERS FEEDERS CONTROLS

Circled area shows 40′ digester with PFT Floating Cover



Florida's fastest growing city

ADOPTS PFT "CONTROLLED DIGESTION"

Carol City now equipped with privately owned sewage treatment plant

With 10,000 houses scheduled for construction in three years, Carol City ranks as Florida's largest housing project and one of the fastest growing cities of recent years. Its privately owned and operated activated sludge plant will grow at the same rapid pace and is expected to serve 40,000 by 1957. Using modern materials throughout, Carol City chose PFT equipment for effective "controlled digestion."

A key feature of the plant is the 40′ digester equipped with a *PFT Floating Cover* for positive scum submergence and complete, effective treatment. Operations are simplified because no fixed levels need be maintained—the cover simply rises or lowers with additions and withdrawals.

Floating Covers also reduce explosion hazards because gas collected under the cover is maintained at positive pressure under all operating conditions. Costly breakdowns are reduced because all moving parts are eliminated from inside the digester.

A PFT Waste Gas Burner was installed to prevent odor nuisance and burn off *safely* all excess gas produced in the digester.

PFT assured the successful operation of Carol City's equipment by checking the installation and instructing plant personnel in the proper methods of operation.

Design of plant by / *Clifford, Cooper & Associates, Inc. Miami Springs, Fla.*

waste treatment equipment exclusively since 1893

P.F.T.

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VASTLY INCREASED POWER . . . POSSIBLY ATOMIC . . . highly compressed into smaller space, may give Man an engine that will enable him to sustain individual, wingless flight.

100 years from now...

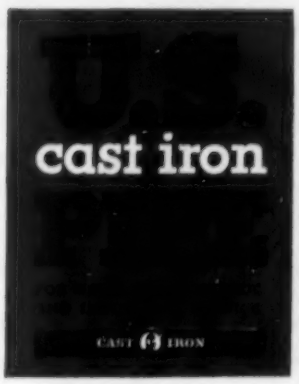
WE MAY "FLY LIKE THE BIRDS"

Time and the future will reveal many wonders...

But in that Jules Verne-like world of tomorrow you'll find one familiar note: water and gas will still be carried by the dependable cast iron pipe laid today.

Throughout the nation, records show that over sixty American cities still use cast iron water and gas mains laid more than a century ago. No pipe can match cast iron's demonstrated longevity. And today, U. S. Pipe, centrifugally cast, is even stronger, tougher, more durable.

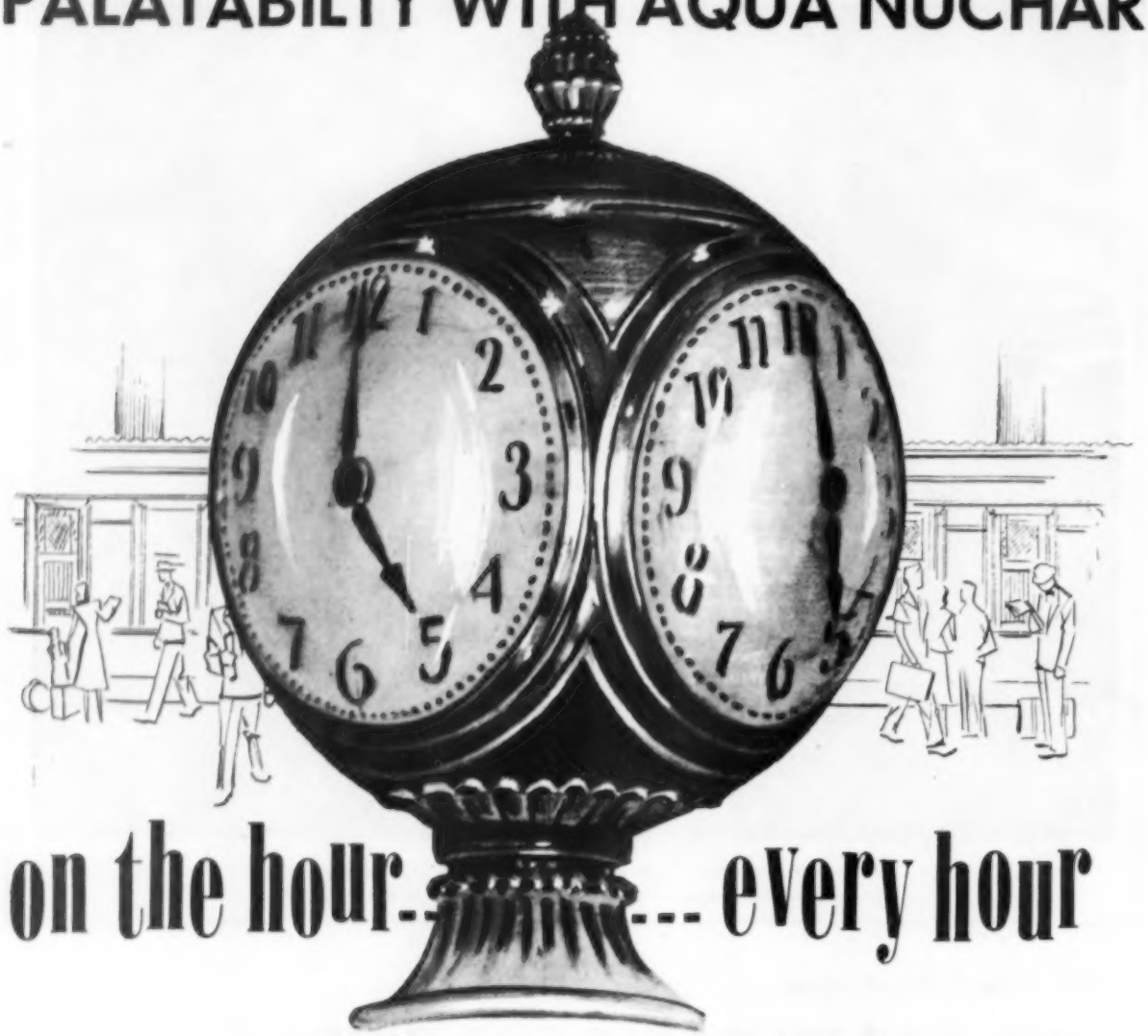
U.S. Pipe is proud to be one of the leaders in a forward-looking industry whose service to the world is measured in centuries.



U. S. PIPE AND FOUNDRY COMPANY, General Office: Birmingham, Alabama

A WHOLLY INTEGRATED PRODUCER FROM MINES AND BLAST FURNACES TO FINISHED PIPE.

PALATABILTY WITH AQUA NUCHAR



on the hour--- every hour

The Threshold Odor Test* is a valuable procedure for determining odor concentration in water. In some industrial areas where water plant operators are faced with extremely high threshold odors performing threshold odor tests on the hour every hour, is the only method of determining the amount of Aqua Nuchar Activated Carbon necessary to deliver a palatable water at all times.

The laboratory records of threshold odor tests have been extremely valuable in measuring the effectiveness of Activated Carbon under variable odor conditions. One plant faced with a severe odor problem has thus been able to deliver a constant palatable water supply for two years without a single odor complaint.

Ever mindful of the problems of achieving good tasting water, Industrial Chemical Sales Division provides a technical staff ready to aid in solving odor problems. Without obligation they will conduct a survey and instruct your operators in running the threshold odor tests, and advise as to the most efficient methods of producing palatable water and the most effective means of use of Aqua Nuchar Activated Carbon along with other water treatment chemicals.

NUCHAR

industrial CHEMICAL SALES
division west virginia pulp and paper company

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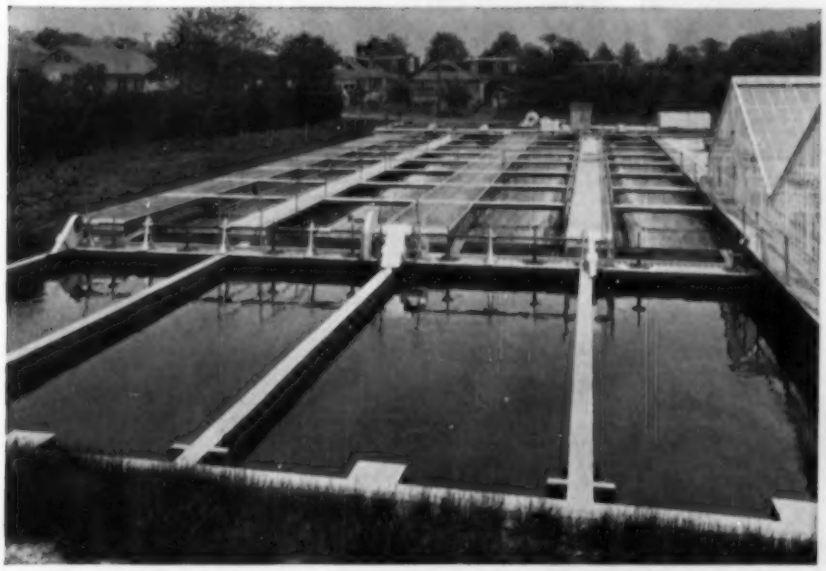
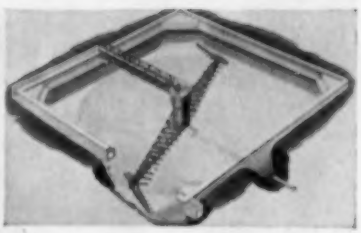
2775 S. MORELAND BOULEVARD, CLEVELAND 20, OHIO

Details for conducting this test will be furnished upon request.

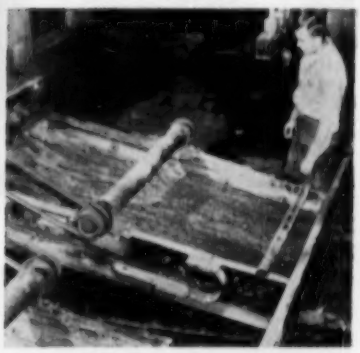
Call on LINK-BELT for water, sewage and waste treatment equipment built to last



STRAIGHTLINE COLLECTORS for rectangular settling tanks. Peak-cap bearings, pivoted flights and Straightline action all contribute to top efficiency. *Chain in system shown installed in 1930 gave 15 years of continuous 24 hour service before replacement.*



CIRCULINE COLLECTORS for square or round tanks for quick, positive sludge and scum removal in shortest time without septicity.



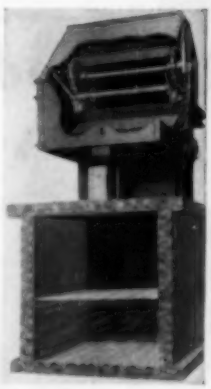
LIQUID SCREENS have proved efficient and economical for removing solids from industrial liquids. Available in several sizes with fine cloth.

ONE SOURCE . . . ONE RESPONSIBILITY

LONG life decides the eventual economy of sanitary waste treatment equipment. And after years of operation, Link-Belt systems in cities both large and small continue to provide highly effective water purification and sewage treatment service . . . with negligible maintenance expense.

Link-Belt equipment has also been welcomed in industrial plants of all kinds — particularly in states having strict anti-pollution legislation. For Link-Belt equipment can dispose of wastes at lowest cost — recover by-products for highest profit.

Link-Belt offers you a broad line of top-quality equipment . . . plus engineering proficiency acquired in over 34 years' experience. Our specialists will be glad to work with your own engineers, chemists and consultants to bring you the finest in modern treatment methods. Call your nearest Link-Belt office for full information and catalogs on the Link-Belt products shown here.



THRU-CLEAN BAR SCREENS — Remove large floating particles from large volumes of water — thus protect other equipment.

TRITOR SCREENS — For small sewage treatment plants—remove both grit and screenings with one mechanism.

CHEMICAL MIXERS — Link-Belt builds Straightline (shown) and flash mixers. Efficiency is assured by operation at variable speed for maximum floc formation.

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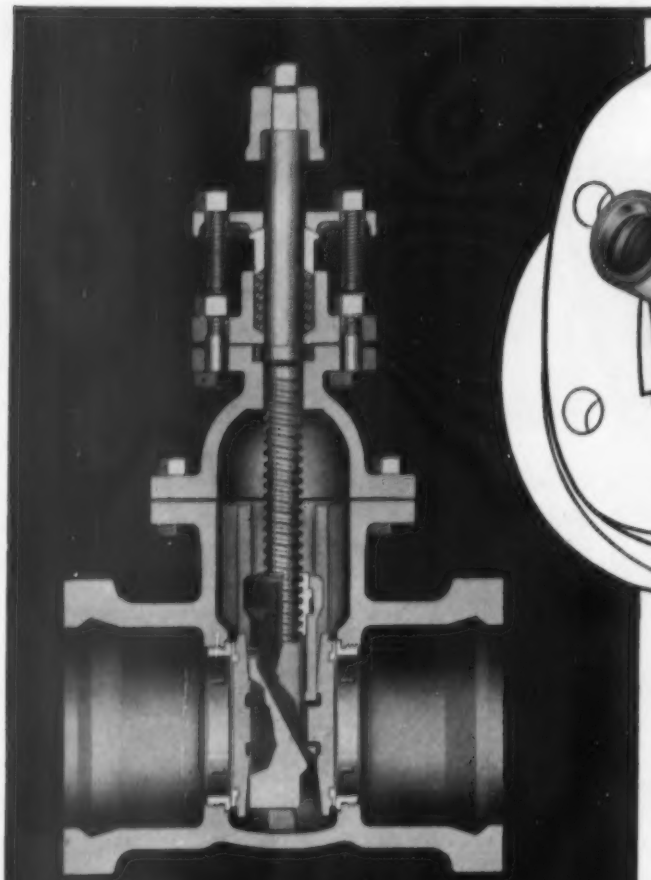
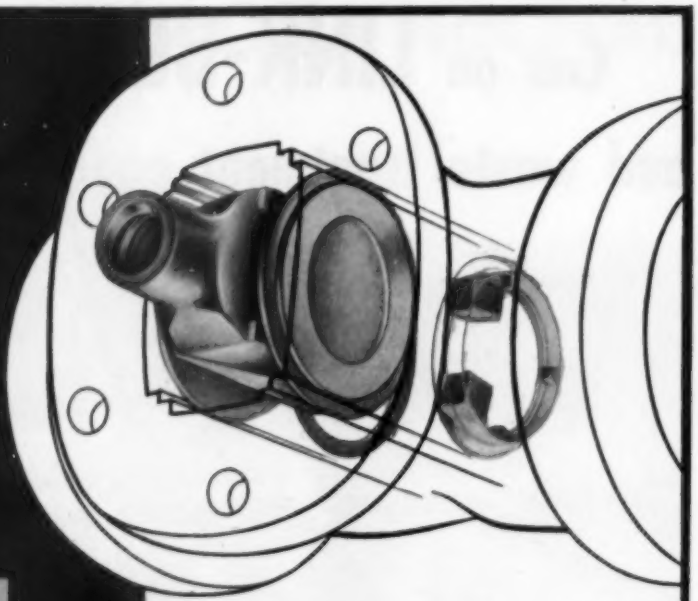
SANITARY ENGINEERING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13.777



Cross Section—No. 480½—Hub Ends



Inside view of valve—shows guide rib feature. Disc assembly rides freely between the ribs, being held closely in open position but free enough in closed position to allow for wedging action of the spreaders.

Four simple parts make up this foolproof disc assembly. The discs are trunnion-mounted, and revolve freely in openings in the upper spreader which is attached to stem. As disc assembly descends, the lower spreader strikes a boss in the body. Further closing movement engages the angular surfaces (one straight, the other slightly rounded for ball to flat contact) between the upper and lower spreaders, and wedging action forces discs tightly against the seats.

Free-to-rotate discs reduce wear in new Crane AWWA Valves

Double discs that rotate freely to prevent concentrated disc and seat wear—plus an exclusive disc guiding design that assures good alignment for maximum efficiency—are just two features of the new Crane AWWA double disc, parallel seat gate valves.

The simple, foolproof, four-piece disc and spreader unit is easily assembled and will not disengage in service—discs are identical and interchangeable. Famous Crane two-piece gland and gland flange with ball-type joint protect against stem binding. In addition, these valves conform in every way to AWWA standard specifications.

These iron body, brass-trimmed gate valves have non-rising stems, and are available in 2″, 3″, 4″, 6″, 8″, 10″ and 12″ sizes. (For larger valves, see your Crane catalog). Write for descriptive folder.

Crane Co., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. Branches and Wholesalers serving all areas.

No. 2485—Flanged Ends

No. 2487½ Mechanical Joint Ends

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BRING THEM TO BJ

BJ SUBMERSIBLES

Byron Jackson manufactures all three basics of a submersible . . . the PUMP . . . the SEAL . . . and the MOTOR . . . and combines them in BJ Submersibles and Subettes. Complete range of sizes and types. Capacities range from 30 to 20,000 gpm, and heads up to 1800 ft. BJ Submersibles can be applied to all deepwell problems.

BYRON JACKSON IS READY TO WORK WITH YOU ON YOUR PUMPING PROBLEMS . . .

1. **BJ supplies a *complete* line of centrifugal pumps and mechanical seals.**
2. **BJ can job-engineer any special pump to the required capacity, head, pressure and power.**
3. **BJ has competent sales engineers in 36 cities throughout the country.**
4. **BJ backs you by parts and service facilities of a long-established nation-wide organization (since 1872).**

BJ SUBMERSIBLE BOOSTER PUMPS

Complete pumping stations can be placed underground, under streets, parks, etc. Eliminate real estate investment and economically boost pressure for sub-division expansion, etc.

Write for BJ Bulletin No. 55-2-700

BJ DEEPWELL TURBINE PUMPS

Bowl and impeller assemblies to meet every deepwell need. Standard models for wells 6", 8", to 24" dia., capacities to 9000 gpm, heads to 600 ft. "Bee Jay" models for 4", 5" and 6" dia. Choice of water or oil-lubrication.

Send for BJ Bulletin No. 54-1-10,000

BJ LAKE AND RIVER INTAKE PUMPS

These pumps eliminate high or low water and icing problems on lake and river intake installations. Capacities to 20,000 gpm. Water-jacketed to operate in or out of water.

BJ BILTON PUMPS

General purpose pump with close-coupled motor pump unit. Mounts in any position. No rigid foundation needed. Ideal for portable service. Capacities to 2000 gpm, heads to 600 ft. Wide range of sizes.

Write for BJ Bulletin No. 353-1000

BJ HYDROPRESS PUMPS

Double-case pumps suitable for hydraulic press, boiler feed and descaling operations, other high-pressure, low-capacity water pumping requirements. Capacities to 500 gpm. Heads to 7000 ft.

Write for BJ Bulletin No. 52-6400

BJ VERTICAL PROPELLER PUMPS

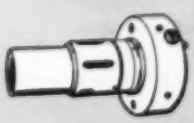
Single-stage pumps. For medium to high capacity jobs with low heads. Capacities to 50,000 gpm. Heads to 40 ft. For drainage, river-intake, dewatering, irrigation, etc. Easily adapted to special needs.

Write for BJ Bulletin No. 53-5800

BJ VERTICAL CIRCULATING PUMPS

Single or multi-stage. For pumping medium to high capacities of water. Two size ranges. Capacities to 50,000 gpm. Heads to 40 feet. Saves space, simplifies piping. For cooling tower, dewatering, drainage, river-intake and circulating.

Send for BJ Bulletin No. 52-6050



BJ MECHANICAL SEALS

High precision seals which replace standard packing in stuffingboxes. Types to fit all centrifugal pumps. Available for handling different pressures, temperatures and liquids.

Send for BJ Bulletin No. 54-1-10,000

BJ

SINCE 1872

Byron Jackson

DIVISION OF BORG-WARNER CORPORATION

P.O. BOX 2017, TERMINAL ANNEX
LOS ANGELES 54, CALIFORNIA

How this hydrant

PAYS A BONUS!

It's unique...it's the B-50-B

EVERY new installation of Darling B-50-B A.W.W.A. Hydrants . . . proves the advantages this new hydrant offers you.

Darling's ball bearing design cuts required operating torque more than 50%—an important factor in *any* system. Action is easy, smooth and sure!

Darling "O" ring seals provide a *dry-top, packless* hydrant, minimizing service and maintenance needs and eliminating the hazard of water reaching the operating threads.

This operating surety and low-cost performance of Darling B-50-B hydrants are bonus values that just can't be matched. You can get the B-50-B design in a wide range of Darling hydrant types to meet your particular installation requirements.

Send for Bulletin 5403

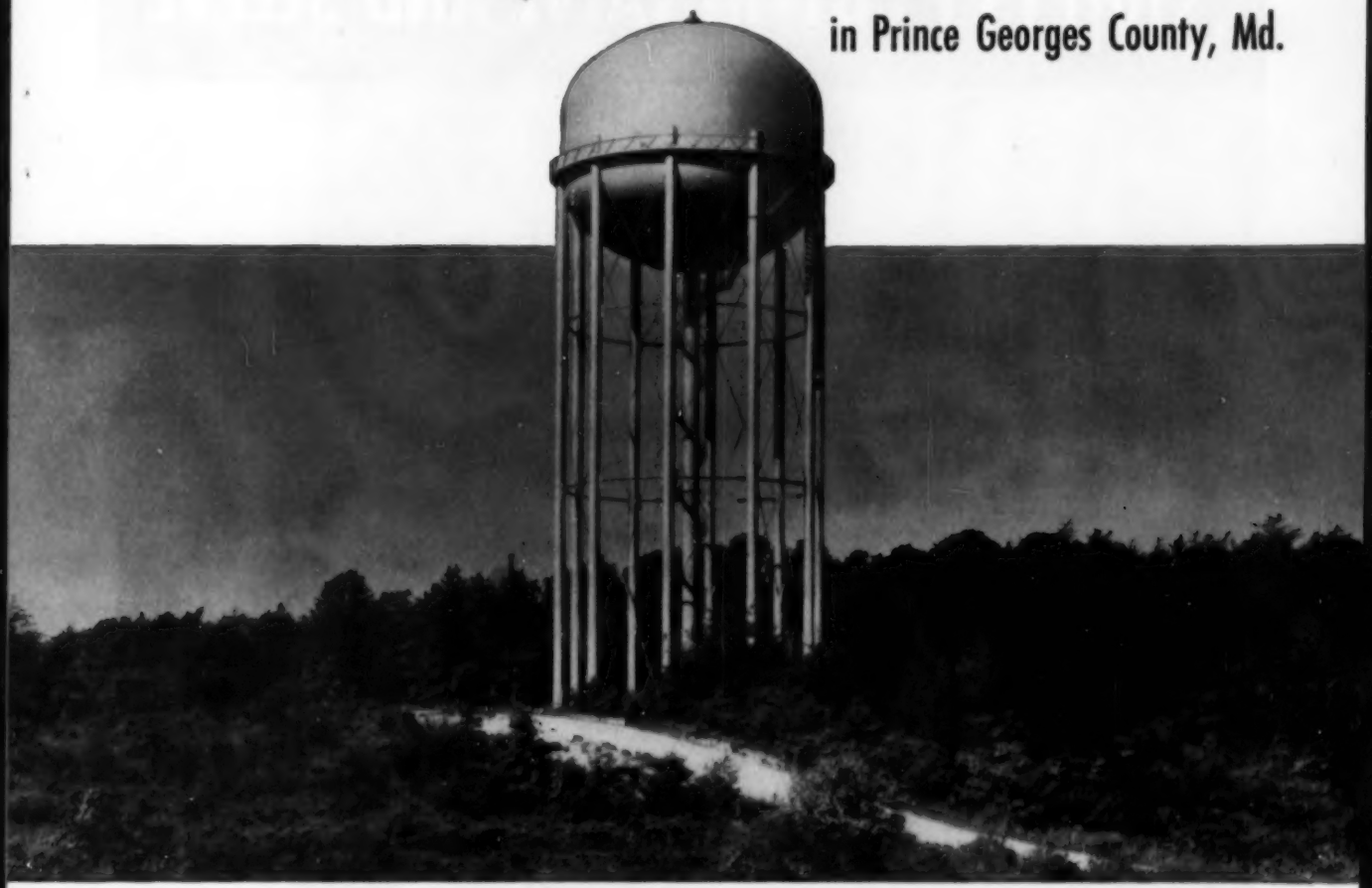
DARLING VALVE & MANUFACTURING CO.

Williamsport 11, Pa.

Manufactured in Canada by
The Canada Valve & Hydrant Co., Ltd., Brantford 7, Ontario.

TRADE DARLING MARK

Water rides on a tall tower for better consumer service in Prince Georges County, Md.



Elevated Steel Tanks

by PITTSBURGH • DES MOINES

A million gallons of water, 160 ft high in this P-DM elevated steel tank, "rides" on the Washington Suburban Sanitary Commission system at a location distant from the source of supply. A relatively high head range of 47 ft accommodates the variations in supply pressure, so that water may always accumulate during off-peak hours and be available to augment the supply at peak demand periods. Diameter of the tank is 65 ft. • A broad picture of the many Pittsburgh-Des Moines Elevated Steel Tank types is provided in our illustrated 20-page brochure. Write for your free copy.

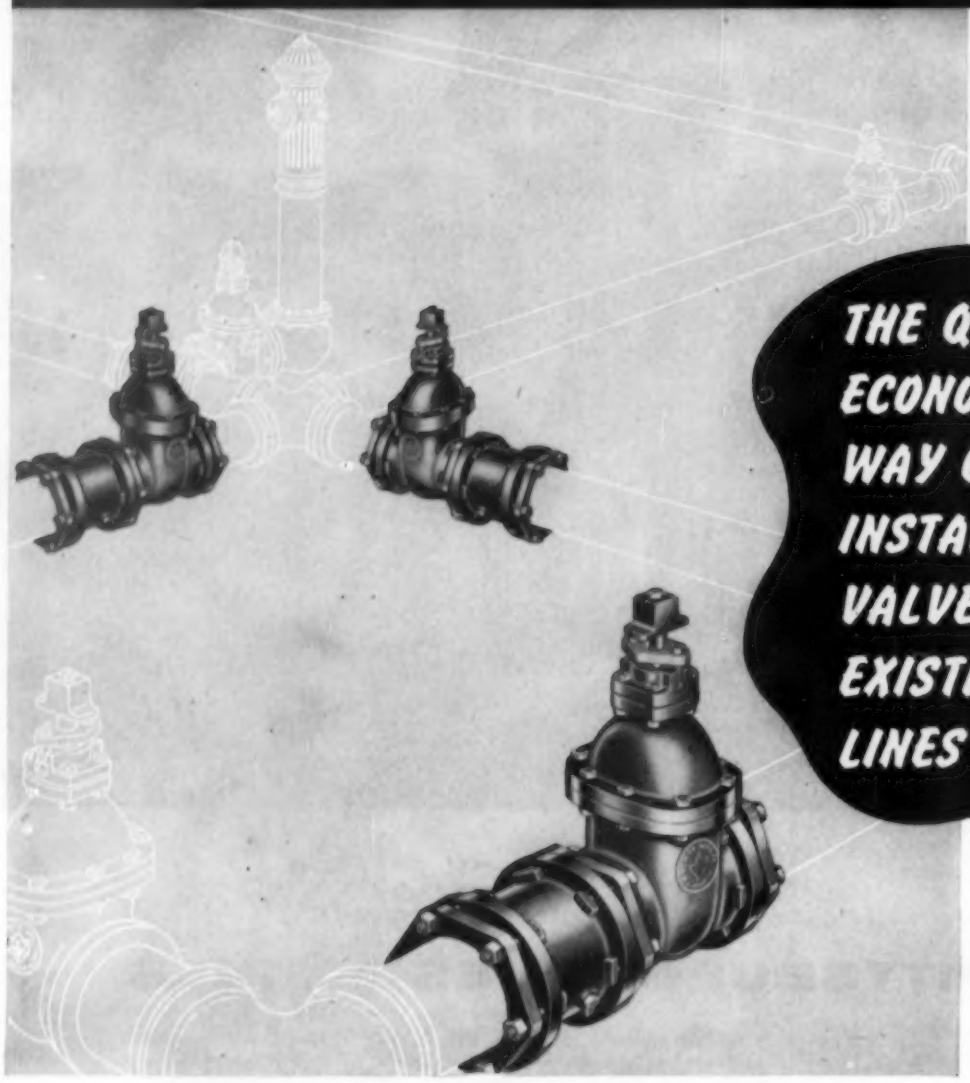
PITTSBURGH • DES MOINES STEEL CO.

Plants at PITTSBURGH, DES MOINES and SANTA CLARA

Sales Offices at:

PITTSBURGH (25)	3418 Neville Island	DES MOINES (8)	913 Tuttle Street
NEWARK (2)	218 Industrial Office Bldg.	DALLAS (1)	1223 Praetorian Bldg.
CHICAGO (3)	1222 First National Bank Bldg.	SEATTLE	526 Lane Street
LOS ANGELES (48)	6399 Wilshire Blvd.	SANTA CLARA, CAL.	625 Alviso Road

SMITH CUT-IN VALVE AND SLEEVE



The Smith Mechanical Joint Cut-in Valve and Sleeve is truly the answer to the problem of installing gate valves in existing piping which can be relieved of pressure. The design reduces size of excavations, installation time and in-service cost to the minimum. Two substantial stop screws lock the Valve and Sleeve securely in place.

The Cut-in Valve and Sleeve can be installed on any standard class of cast iron pipe. Molded rubber gaskets fit into machined "Stuffing Box Type" joints, which are permanently leak proof. Smith Cut-in Valves are manufactured in compliance with the A.W.W.A. gate valve specification. Write for Bulletin MJ2.

54

FIRE HYDRANTS · VALVES · SINCE 1896

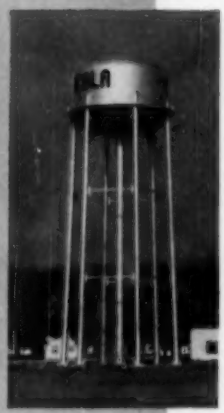
THE A.P. SMITH MFG. CO.

EAST ORANGE, NEW JERSEY

Stars on the Illinois Horizon

• Stars of this sort, may be seen on the horizon of communities throughout the country. Horton® elevated tanks, like these three owned by Illinois Cities Water Company, are helping many communities keep abreast of growing population and customer demand. Horton elevated tanks provide a dependable gravity pressure water supply for emergencies, help to decrease pressure variations and reduce pumping costs.

• Horton elevated tanks are built in sizes to 3,000,000 gals. Write our nearest office for further information.



250,000-gal. Horton ellipsoidal-bottom elevated tank at Tuscola.

Tuscola

Palestine

Mount Vernon

500,000-gal. Horton ellipsoidal-bottom elevated tank at Mount Vernon.

50,000-gal. Horton ellipsoidal-bottom elevated tank at Palestine.

CB&I

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Los Angeles • New York
Philadelphia • Pittsburgh • Salt Lake City • San Francisco • Seattle • Tulsa • Washington
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

Want cobwebs on *your* complaint phone?

Then let Calgon* solve your water problems—and you can say goodbye to complaints of lime scale and red water. Calgon not only stabilizes iron and manganese dissolved in water at its source but also prevents iron pick up from pipes —red water is stopped.

Calgon is just as effective at combating lime scale—in either naturally hard or lime softened water. Scale-forming chemicals are kept in solution, so filters, valves, mains and heaters stay clean, and flow capacities are maintained.

Corrosion control with Calgon† reduces costly tuberculation damage by forming a protective film on metal surfaces. Flows are kept high and pumping costs are lower.

Write or phone for more information about dissolved iron, corrosion and lime scale control with Calgon—or let an experienced Calgon engineer investigate your specific problem.

*Calgon is the Registered Trade Mark of Calgon, Inc. for its glassy phosphate (sodium hexametaphosphate) products.

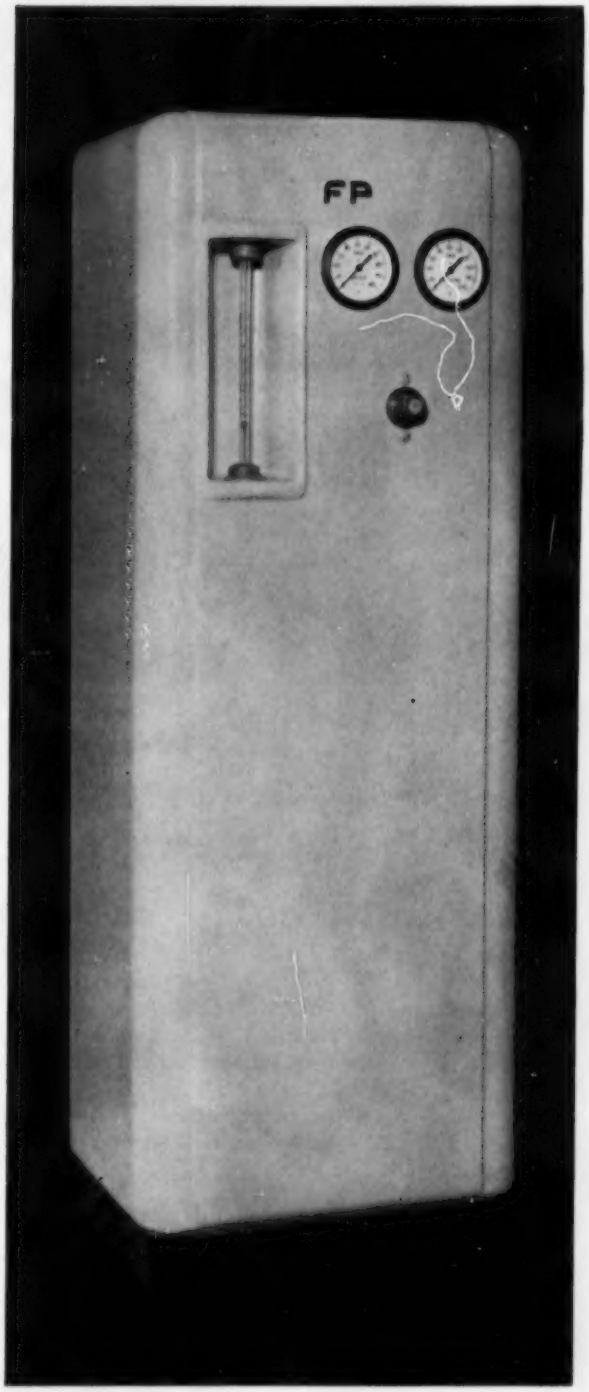
†Fully licensed for use under U. S. Patents 2,337,856 and 2,304,850.

calgon, inc.

A SUBSIDIARY OF HAGAN CORPORATION
HAGAN BUILDING · PITTSBURGH 30, PA.

FP *complete process instrumentation*

ONE Basic F&P Model 1050-A Chlorinator Offers Automatic Proportioning or 4 Other Types of Control



The Fischer & Porter Model 1050-A Automatic Chlorinator is designed for use wherever chlorine feed rate automatically proportioned to main line water flow rate is required. The automatic proportioning device is designed to respond to the flow rate signal of primary measuring elements: differential pressure, open-channel or rotating meters. These signals may be any standard form of transmission.

Like the manual chlorinator, it is simple in design, corrosion resistant, easy to install, low in maintenance cost, and has a Fiberglas* cabinet. In addition, four other types of control are available in the same basic unit: Remote Set, Start-Stop, Multiple Rate (pump sequence), and manual control.

Highlights of the F&P Automatic Proportioning Chlorinator

- All parts for manual and automatic chlorinators are interchangeable
- Any standard type of transmission may be utilized—vacuum, pneumatic, electrical
- Complete vacuum system, independent of the power-operation of the system—not affected by power failure
- Automatic proportioning with accuracy well within 4% is available over a wide range
- Simple conversion in a matter of minutes from automatic to manual operation

Fischer & Porter offers a wide variety of chlorinators for municipal water and sewerage systems, industrial plants, swimming pools. See your local F&P representative or write for free literature.

*Trade Mark OCF Corp.

FISCHER & PORTER COMPANY

COUNTY LINE ROAD • HATBORO 15, PA.

Measuring, recording and controlling instruments
Centralized control systems
Data reduction and automation systems
Chlorination equipment
Industrial glass products

Sales offices in 32 American cities and in principal cities abroad

Valdese Filtration Plant (below), designed by W. K. Dickson & Co., built by Boyd and Goforth, Inc. Complete operating data for the plant is concentrated on a single Brown instrument panel, at left. Below at left is one of the consoles for controlling filter operation.

Honeywell engineered instrumentation automatically controls rapid sand filters

CONTROL of rapid sand filters, at the Valdese Water Filtration Plant, Valdese, N. C., is designed for maximum simplicity and convenience. From the central Brown instrument panel, operators have complete supervisory data on the entire operation . . . supplemented by individual console control of filtration rate and backwashing.

The Honeywell control system provides direct pneumatic operation of filter control valves, without need for the complexities of pneumatic-hydraulic relays. Valves 16" and larger can be opened or closed at the turn of a switch. Rate of filtration, too, is a single switch adjustment. Control is so designed that the plant automatically shuts down when levels in the reservoir and clear wells reach maximum limits.

This simplified system assures reduced costs for initial installation and for day-to-day operation of the plant. It provides maximum economy of treatment agents and water, through close correlation with laboratory testing. Pipe galleries stay clean and dry. And operators can supervise the functioning of the plant efficiently, without waste of time and power.

For the new water or waste treatment facilities you are planning, it will pay to have a Honeywell field man discuss Honeywell's field-proven new automatic filter control, with you and your consulting engineer. Call him today . . . he's as near to you as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

MINNEAPOLIS **Honeywell**

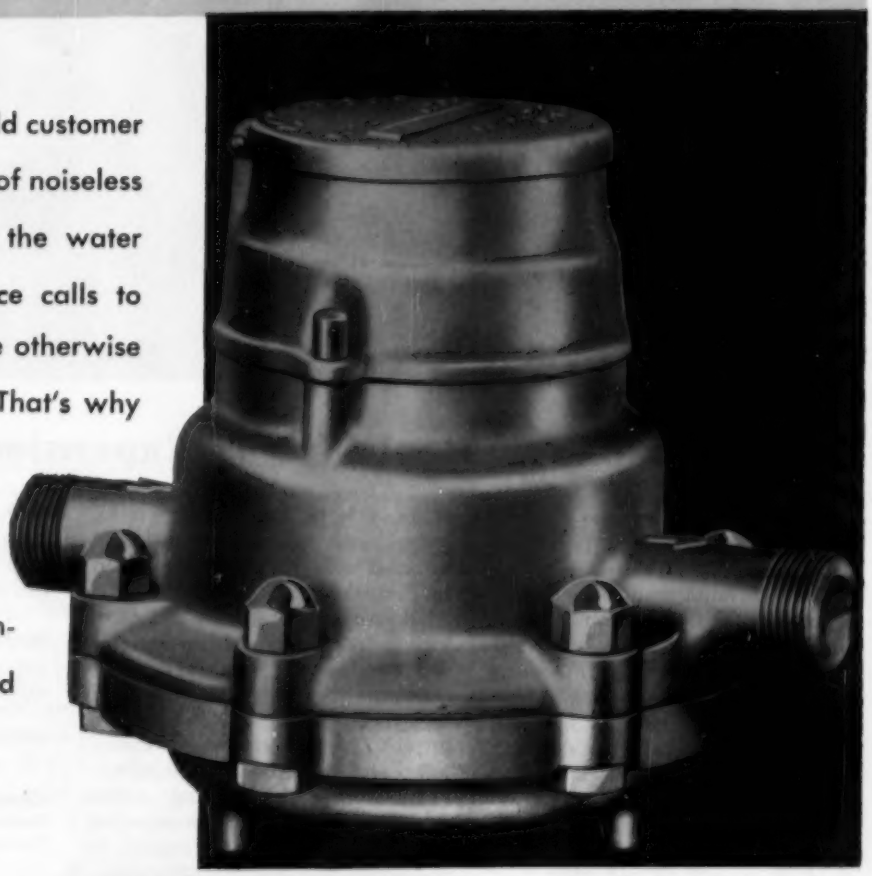
BROWN INSTRUMENTS

First in Controls

Because: It's Quiet

"American Meters operate silently. In my job in charge of service, I never find them noisy, even after years of operation. That's another reason why we always feel safe in buying American."

The Safest Meter to Buy is AMERICAN



• American Meters build customer satisfaction with years of noiseless operation. It relieves the water department of nuisance calls to replace meters that are otherwise functioning correctly. That's why the foreman who likes to operate his meter department without customer complaints, plays safe and buys American.

BUFFALO METER CO.

2909 MAIN STREET • BUFFALO 14, N. Y.

Omaha Uses Steel Pipe in Expansion Program

Now nearing completion is a three-year, $12 million water plant improvement and expansion program of Omaha's municipally owned Metropolitan Utilities District. Its immediate objective is to boost the output capacity of the Florence Water Works (the pumping station which supplies all water for the city) to 120 million gallons per day and to expand distribution and storage systems accordingly.

Vital to the program was the installation of approximately 7500 ft of 48 in. x ⅜ in. and 2500 ft of 36 in. x ¾ in. steel trunk mains, coated with coal-tar enamel and wrapped with asbestos felt, supplied by Bethlehem.

Bethlehem Tar-Enameled Steel Pipe offers many advantages for water and sewage lines. Its superior strength, its ability to withstand high pressures from within as well as impact from without, its leakproof joints and its corrosion-resisting tar-enamel lining and coating, assure you of a quality of service unequalled by any other material. Available in economically installed 40-ft lengths, Bethlehem Steel Pipe comes in a complete range of diameters from 18 in. ID to the largest permitted by common carriers.

For further information about Bethlehem Steel Pipe, we suggest you contact the nearest Bethlehem sales office.

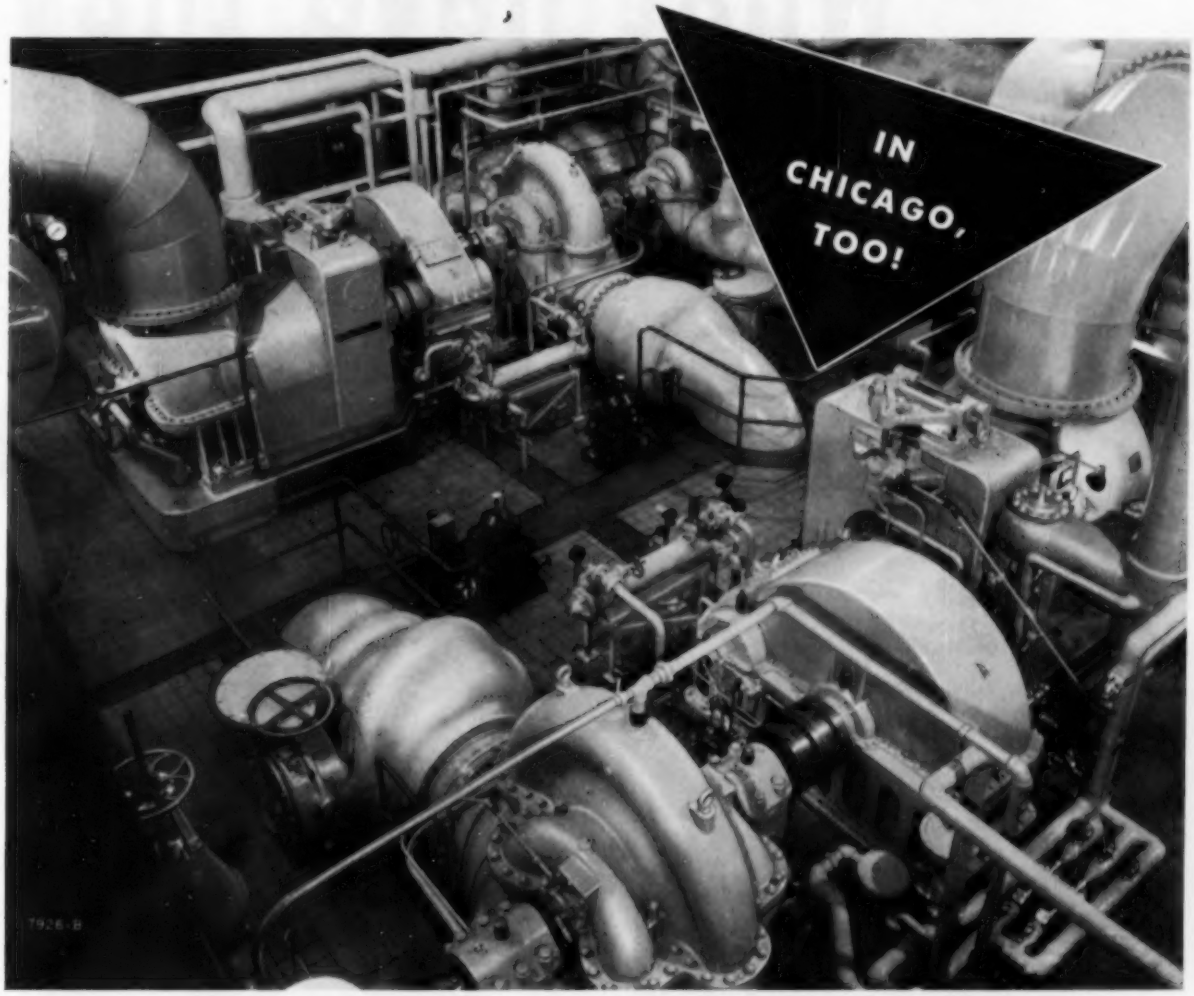
BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

DE LAVAL pumps America's water...



The two De Laval centrifugal pumps shown in the photograph are on the job in the Mayfair station of the Chicago water works system. They each have a rated capacity of 30 million gallons per day. De Laval has supplied 28 units for the various Chicago stations with a total rated capacity of 1695 million gallons per day. Two additional units are on order which will bring the capacity to 1825 mgd in the near future.

Today, 80% of the cities in the United States with a population of 100,000 or over use De Laval centrifugal pumps. Capacities of De Laval centrifugal water works pumps range from 100 thousand to 100 million gallons per day. *Write for your copy of new De Laval Bulletin 1004 giving data on these pumps.*

MR. JAMES W. JARDINE
Commissioner
Department of Water & Sewers

MR. W. W. DEBERARD
Deputy Commissioner for Water and Chief Water Engineer

MR. O. B. CARLISLE
Chief Water Works Engineer
Department of Public Works

MR. JAMES L. WEEKS
Mechanical Engineer in Charge Operating Division

DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY

824 Nottingham Way, Trenton 2, New Jersey

DL 333

what have they

The rhino lives in wooded, watery districts of Africa and Asia. Its temper is short, its eyesight dim but its scent and hearing are very acute. Though heavy, it is extremely fleet of foot. It feeds mostly at night and its diet is largely vegetarian.

This cast iron main laid in Richmond in 1830 is still functioning after more than a century of service.

MODERNIZED cast iron

in common...

THE RHINO AND CAST IRON PIPE...TOUGHNESS!

The thick, tough hide of the rhinoceros makes it one of the hardest animals to bring down. Toughness is also a dominant feature of CAST IRON PIPE. It serves for centuries.

AND HERE'S THE PROOF: Listed below are some of the many water utilities still using cast iron pipe that was installed a century or more ago.

DEPARTMENT OF WATER AND WATER SUPPLY, City of Albany, New York
ALEXANDRIA WATER COMPANY
Alexandria, Virginia
BUREAU OF WATER, DEPT. OF PUBLIC WORKS, Baltimore, Maryland
PUBLIC WORKS DEPT., WATER DIVISION
Boston, Massachusetts
DEPARTMENT OF PUBLIC WORKS, DIVISION OF WATER, Buffalo, N. Y.
WATER WORKS DEPARTMENT
Chicago
COLUMBIA WATER COMPANY
Columbia, Pennsylvania
BOARD OF WATER COMMISSIONERS
Detroit, Michigan
CITY OF FREDERICK WATER DEPT.
Frederick, Maryland
PUBLIC SERVICE COMMISSION
City of Halifax, N.S., Public Water Supply
WATER BUREAU OF THE METROPOLITAN DISTRICT, Hartford, Connecticut
MUNICIPAL WATER WORKS
Huntsville, Alabama
BUREAU OF WATER
Lancaster, Pennsylvania
CITY OF LYNCHBURG WATER DEPARTMENT, Lynchburg, Virginia
MOBILE WATER WORKS COMPANY
Mobile, Alabama
QUEBEC HYDRO-ELECTRIC COMMISSION
Montreal, Quebec
PUBLIC WORKS DEPT., WATER-WORKS & SEWERAGE DIV., Montreal, Quebec
PENNICHUCK WATER WORKS
Nashua, N. H.
WATERWORKS DEPARTMENT
City of Nashville, Tennessee
DEPT. OF WATER, GAS & ELECTRICITY
New York, New York
DEPT. OF PUBLIC WORKS, BUREAU OF WATER, Philadelphia, Pennsylvania
BUREAU OF WATER, DEPT. OF PUBLIC WORKS, Pittsburgh, Pennsylvania
POTTSVILLE WATER COMPANY
Pottsville, Pennsylvania
BUREAU OF WATER
Reading, Pennsylvania
DEPT. OF PUBLIC UTILITIES (WATER)
Richmond, Virginia
DIVISION OF WATER & SEWERS
Sacramento, California
WATER & SEWERAGE DEPARTMENT
City of Saint John, N.B.
DEPT. OF PUBLIC UTILITIES, WATER DIVISION, St. Louis, Missouri
WATER DIVISION, DEPT. OF ENGINEERING, Syracuse, New York
DEPT. OF PUBLIC WORKS
Troy, New York
CITY OF UTICA, BOARD OF WATER SUPPLY, Utica, New York
CITY OF WHEELING WATER DEPT.
Wheeling, West Virginia
WILMINGTON WATER DEPT.
Wilmington, Delaware
WATER DEPARTMENT
City of Winchester, Virginia
WATER DEPARTMENT
City of Winston-Salem, North Carolina
YORK WATER COMPANY
York, Pennsylvania
WATER DEPARTMENT
City of Zanesville, Ohio

TODAY... modernized cast iron pipe, centrifugally cast, is even tougher, stronger, more uniform. *Where needed and specified,* it is centrifugally lined with cement mortar to assure sustained carrying capacity throughout its long years of service.

On its record, CAST IRON PIPE is the world's most dependable carrier of water.

Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director,
122 So. Michigan Avenue, Chicago 3.

CAST Q IRON

The Q-Check stenciled on pipe is the Registered Service Mark of the Cast Iron Pipe Research Association.

pipe FOR MODERN WATER WORKS OPERATION

CAST TO LAST 100 YEARS

The name "CLOW" cast on the face of cast iron pipe is your guarantee of high quality. This distinctive "autograph" marks the precise, modern production methods, and the advanced, exacting control of quality employed by James B. Clow & Sons, Inc., to assure you the finest cast iron pipe . . . pipe cast to last 100 years.

For more than 75 years waterworks operators and municipal officials have looked to Clow for high quality and good service. Clow cast iron pipe exceeds the physical requirements of all currently approved specifications.

JAMES B. CLOW & SONS

INC.

201-299 North Talman Avenue • Chicago 80, Illinois

Subsidiaries:

Eddy Valve Company, Waterford, New York

Iowa Valve Company, Oskaloosa, Iowa

How Do You Measure Quality In Water Meters ?

You can't put a gauge on quality . . . and only in part a price. You who have been "through the mill" know that quality in water meters must be demonstrated over the years by superior performance, greater accuracy, longer life. Then it's a matter of record.

By any yardstick Rockwell meters measure up to the highest standards. They provide the most in accuracy with the least wear. It adds up to greater earning power, fewer repairs, lowest cost per unit measured. Ask our representative to demonstrate or write for bulletins.

The Symbol for Service, Quality and Performance in Water Meters

ROCKWELL MANUFACTURING COMPANY

PITTSBURGH 8, PA. Atlanta Boston Charlotte Chicago Dallas Houston Los Angeles Midland, Texas
N. Kansas City, Mo. New York Philadelphia Pittsburgh San Francisco Seattle Shreveport, La. Tulsa

ROCKWELL WATER METERS

north, south, east, west...

"CENTURY"® PIPE

cuts costs, saves tax dollars!

Across America, thrift-conscious communities are recognizing the economy of "Century" Asbestos-Cement Pipe. Whether used in extending old water mains, or in installing new water distribution systems, "Century" Pipe brings the advantages of low cost . . . ease of installation . . . remarkable durability.

Its low installation cost reduces initial dollar outlay, cuts carrying charges over the years. Through generations of maintenance-free service, "Century" Asbestos-Cement Pipe retains its clean, smooth bore—minimizing friction and keeping pumping costs low.

Investigate the many other important advantages of "Century" Asbestos-Cement Pipe and you'll fully understand why it's in growing demand—why it's the best choice for your next water main installation! *Write today for a copy of our free booklet, "Mains Without Maintenance."*

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

K&M best in asbestos®

Chicago South District Filtration Plant

Years and Years Ahead in **PNEUMATIC** Instruments and Controls For Water Works Service

Because this equipment is specially designed for water works service, the Builders Pneumatic System is outstandingly successful in operation. Builders Pneumatic Instruments and Controls are now giving top performance on many important installations across the country, including Chicago's South District Filtration Plant, the world's first and largest pneumatically equipped plant, built in 1946.

Builders Pneumatic Meters and Controls are right for water works service in every detail — in accuracy, in range, and in materials of construction. Each system profits by our broad design and manufacturing experience . . . a "plus" service we extend to engineers to help in obtaining the correct instruments and controls for each project. Builders-Providence equipment is backed by our own nationwide organization of service specialists . . . another assurance of economical plant operation.

For a first-hand look at the advantages of Builders Pneumatic Instruments and Controls, visit one of the many installations now in service. We will be glad to help arrange such a visit for you. Write Builders-Providence, Inc., 350 Harris Ave., Providence 1, Rhode Island.

BUILDERS-PROVIDENCE

DIVISION OF B-I-F INDUSTRIES, INC.

BUILDERS IRON FOUNDRY • PROPORTIONEERS, INC. • OMEGA MACHINE CO.

B-I-F METERS FEEDERS CONTROLS

Other Mueller Water Works Equipment (a partial list)

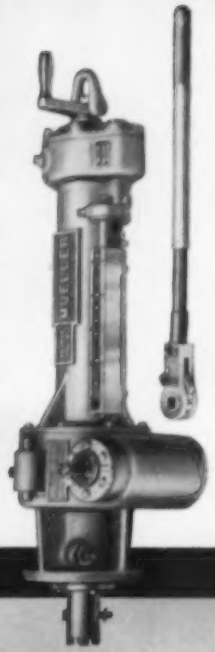
CURB BOXES

CHECK VALVES

RELIEF VALVES

DRILLING MACHINES

COMPRESSION STOPS



Corporation Stops

Ground key construction . . . designed for insertion into mains under pressure . . . precision fitted and individually lapped into body . . . complete range of sizes . . . variety of inlet and outlet threads and connections.

Drilling Machines

Hand operated or power-operated with gasoline engine or air motor . . . drills 2" through 12" in any type or size main . . . automatic tool feed . . . working pressure to 500 p.s.i. . . . smaller drilling machines available with varying capacities up to 2".

MUELLER

FOR THE FINEST IN WATER WORKS EQUIPMENT

SERVICE FITTINGS

FLOOR STANDS

GOOSENECKS

METER STOPS

REGULATORS

SERVICE CLAMPS

BRANCH CONNECTIONS

TAPPING VALVES

Meter Setting Equipment

Relocater yokes designed to raise meter without changing fittings or disturbing piping . . . makes meter easier to read and change . . . piping is rigid even with meter removed . . . complete variety of standard types and sizes available.

Gate Valves

Improved design features "O" ring stem packing . . . lubricated thrust collar . . . no maintenance needed . . . exclusive "four-point-contact" disc wedging mechanism assures positive seal . . . now available with "Ring-Tite" connections for class 150 "Ring-Tite" pipe . . . variety of other connections . . . AWWA.

Inserting Valves

Designed for adding needed control valves without hazardous shutdown . . . quickly installed in line under pressure . . . operated like standard gate valve . . . working parts interchangeable with AWWA gate valve . . . sizes 4″, 6″ and 8″.

Curb Stops

Ground key construction . . . precision fitted and individually lapped . . . proper taper of key assures easy operation and long life . . . inverted key or solid head type . . . complete range of sizes, types and connections.

Fire Hydrants

Improved design incorporates all the latest hydrant features . . . compression-type main valve . . . safety flange and stem coupling . . . "O" ring stem seals . . . self-oiling reservoir . . . double drain valves . . . dry top design . . . now available with "Ring-Tite" inlet connection.

Demands for better water works equipment to meet growing water works needs, coupled with the Mueller policy of constant product improvement and development, have resulted in the new and vastly improved products shown. These products are just a portion of the complete selection of water works equipment, supplies and specialties offered by Mueller Co. and manufactured to characteristically high standards. All Mueller products are fully tested and warranted.

"B" Tapping Machine

Drills and taps mains and inserts corporation stops, ½″ through 1″, under pressure . . . will dry tap ½″ through 2½″ . . . working pressure to 230 p.s.i. . . . similar machine available for inserting corporation stops through 2″.

Cut-In Sleeves and Valves

Companions to Inserting Valves . . . expressly designed for adding needed control valves where water can be shut off for installation . . . fits all classes of cast iron pipe regularly used . . . sizes 4″, 6″, 8″, 10″ and 12″.

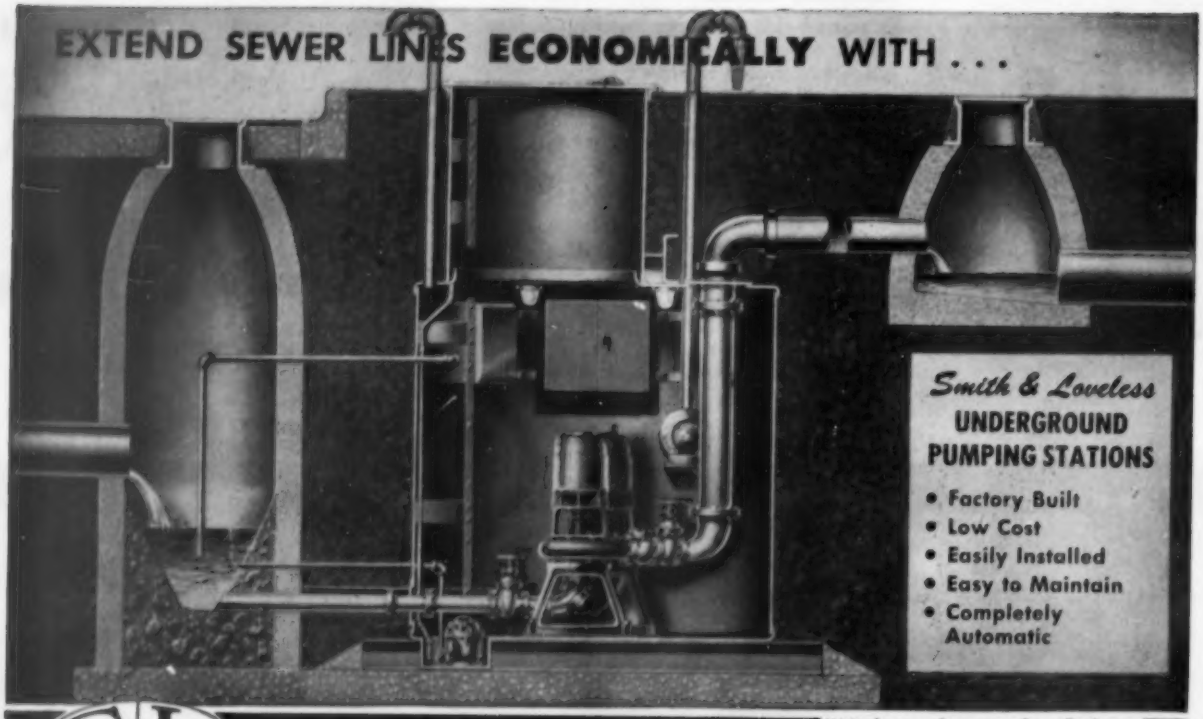
See your Mueller Representative, Catalog W-96 or write direct today for full information.

MUELLER CO.

Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS

EXTEND SEWER LINES ECONOMICALLY WITH . . .



Smith & Loveless
UNDERGROUND PUMPING STATIONS

- Factory Built
- Low Cost
- Easily Installed
- Easy to Maintain
- Completely Automatic

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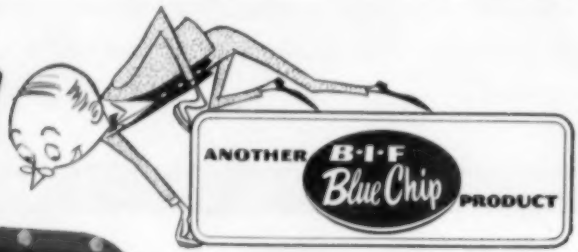

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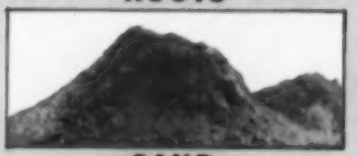

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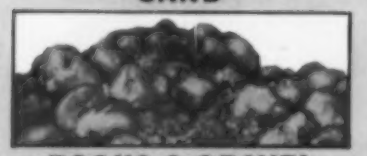

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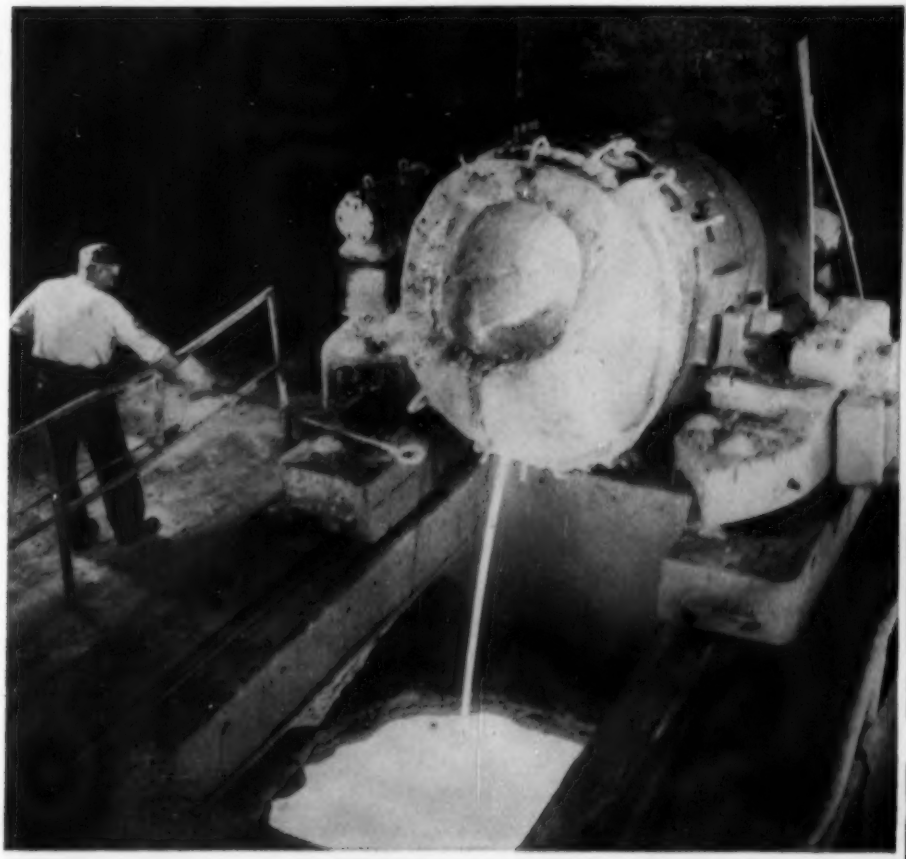

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WATER & SEWAGE WORKS

VOL. 102, NO. 12 • A Scranton Gillette Publication • NOVEMBER 1955

INDIANAPOLIS, IND.—A corner of the meter shop where two test benches are located

Meter Maintenance Increases Revenue

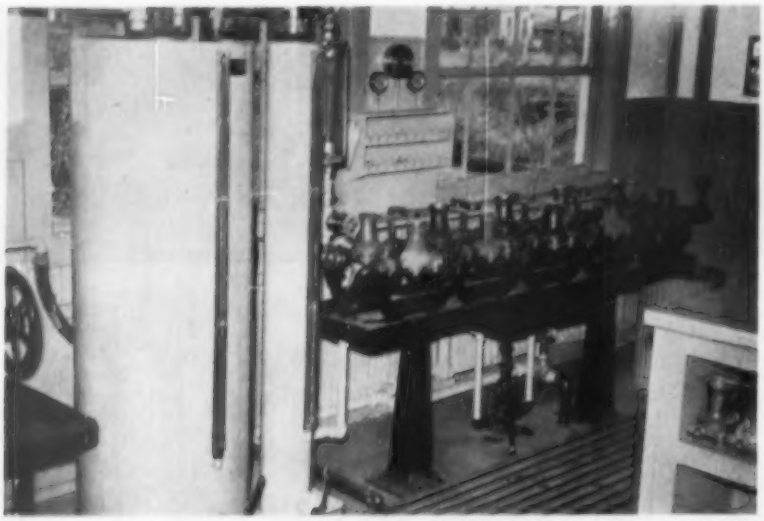
by M. O. HAZLETT

Mr. Hazlett is Sales Representative of the Neptune Meter Co. for the State of Montana. His paper is adapted from one presented by the author at a school for operators and managers of water sewage and industrial waste treatment plants at Montana State College, Bozeman, Mont.

ONCE you have meters in your water system, proper meter maintenance is a logical step. I think you will agree that if meters are worth installing in the first place, they are worth keeping at top efficiency.

There are two major phases in water meter maintenance. One is the problem of testing them; that is, to see at just what level of accuracy they are performing. The other major aspect of maintenance is the problem of repairing them so they will operate properly.

There are many details involved in both these phases of water meter maintenance. Before discussing them, I would like to enumerate some of the reasons for maintenance. As you know, any mechanical device is subject to wear and requires a certain amount of care and service. Water meters are no exception. Today most water system operators are no longer taking it for granted that once meters are installed, the problem of accurate recording of water delivered is solved.



CHAMPAIGN, ILL.—Test bench of meter shop where ten residential-size meters can be tested simultaneously

Of course, we have all heard of cases where meters have functioned for 30 or 40 years without stopping, but experience has led the water works industry to appreciate that meters should be checked for accuracy at intervals between every five and ten years.

If a meter has not stopped after many years of service, it may still have suffered from wear. Even the best made meters, designed and manufactured according to the highest standards, can in time be expected to show the results of use.

Basic Reasons for Maintenance

The basic reason for proper maintenance is that of fairness. If a meter is not functioning properly because of wear, it results in under-registration. And this means that some consumers are, in effect, getting the equivalent of a reduction in their rates ranging anywhere from 5 to 50 per cent. It also means that the rate approved by the city council or the state utility regulatory body is not actually being realized.

Primarily, however, the water system itself suffers from the unfairness that results from under-registration caused by improperly maintained meters. The injustice is done to the men who operate the water works, because the system does not actually receive revenue for all the water it produces, treats and delivers.

Realization of the importance of complete and accurate meter registration is one of the main problems in water distribution. The percentage of accounted-for water is directly affected by accurate registration. This occurs because excessive loss of water is corrected by the detection and repair of leaks in services, hydrants, toilets and other fixtures.

Experience has shown that systems which suffer from extremely high per capita use benefit from accurate registration of water delivered. In the final analysis this results in saving in production, purification, and distribution costs and in many cases contributes to increased revenue.

Only by accurately measuring the water delivered against that consumed can the leakage or waste within the system be held to a reasonable limit. An interesting series of tests conducted at Hartford, Conn., indicated that in houses equipped wtih tank toilets 27 to 50 per cent of the total amount of water used was at rates less than one gallon per minute. Obviously, it is vitally important that meter maintenance be carried to such an extent that accuracy is preserved well below the one gallon per minute rate.

Frequency of Meter Testing

To determine whether a meter is registering with accuracy calls for tests to be made. Tests are generally made before new meters are installed or after old ones have been repaired. But the problem that comes up in periodic testing is the problem of frequency. "How often should water meters be tested," is the question that comes up when thought is given to a meter testing program.

In many states the utility regulatory bodies have set arbitrary limits that range from 5 to 10 years. This refers to the 5/8-inch residential size meter which is in most common use. In some cases this limit is set on total registration figures rather than on a time limit, such as 100,000 cubic feet on the 5/8-inch meter.

Actually, the determination of frequency of meter testing depends on local conditions. Various factors enter into this problem. Water supplies differ materially in the character of the water, and the effect of various kinds of water on meters varies greatly. Water pressure may also be a contributory factor affecting the functioning of meters. While Oregon has a rule requiring testing every three years, the average for other states is either five or ten years for those states that do have a rule. And in a few cases the rule provides for testing every seven or eight years.

The selection of a particular cycle depends on the results of experience in each local situation. Accurate records of meters tested, together with the costs of parts and labor involved, will help determine the frequency finally adopted.

In addition to the factor of the quality of water which differs in each system there are other elements that make it virtually impossible to set universal rules in the field of meter maintenance.

Cost of repairs, which includes labor, transportation of meters from homes to the shop, and the efficiency of different systems are all factors that enter into the picture. And they are all factors that vary not only from state to state, but from town to town in any particular state.

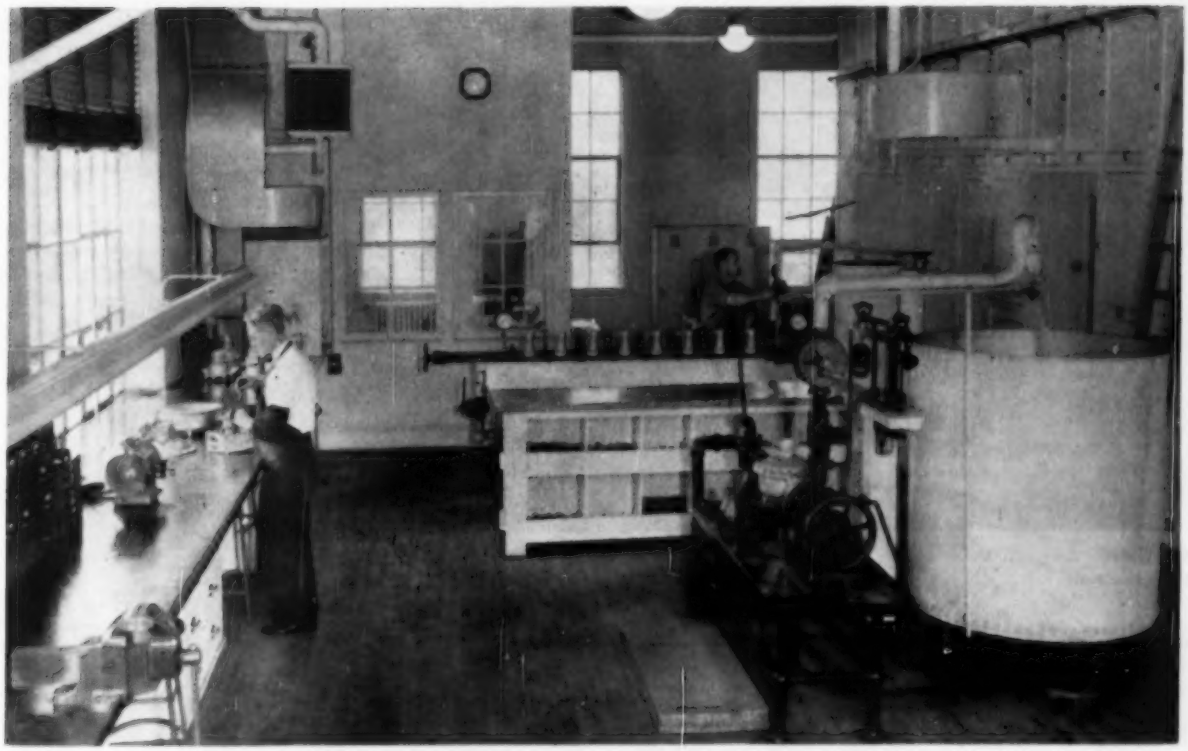
The Meter Maintenance Program

Two general rules that apply to the problem of whether or not it is worthwhile to set up a maintenance program can be cited here.

One rule, less complicated than it appears, states: "In any period of time the highest net revenue from a metered water system is received when the cost of meter repair and maintenance just equals the loss of revenue if such work is not done."

"Highest net revenue" means total collections less meter maintenance and repair. "Period of time" is any period of years, during which all meters have been in the shop at least once.

Another rule (stated by George Sopp, a nationally known expert from the Los Angeles Department of Water and Power) expresses the same thought in another way. Here is what it says: "It is economically advisable to remove a meter for test and overhaul when the average annual cost of such removal and overhaul is equal to the average annual



KENOSHA, WISC.—Meter testing and repair shop layout featuring adequate space and plenty of light

loss of revenue because of the decreased efficiency of the meter."

After frequency, the problem that comes up most often in meter testing is the rate of flow at which tests should be made. Available reports show that tests are conducted at ⅝-inch or ⅝ x ¾-inch at 20 gpm, ¾-inch at 30 gpm, etc., depending on size (1 or 2 gallons per minute) and at a rate of ¼ gallon per minute.

All testing recommendations call for tests to be made at ¼ gallon per minute, because of the large volume of water that is consumed in the average home at the low rate. Then too, it must be kept in mind that drips and small leaks are generally at such low rates of flow that they will not register accurately or at all on any but sensitive meters.

The importance of low-flow testing cannot be stressed too much, since the great majority of domestic water meters are used in services where small flows, one gpm or less, predominate; these small flows make up a total of as much as 50 per cent of total volume of water consumed.

The meter is often called the cash register of the water works industry. A cash register that is inaccurate in recording small denominations would be objectionable in a retail shop and, similarly, in retailing water the importance of low-flow accuracy is apparent when it is recalled that a large percentage of the consumption of the average water utility is in the retail shop classification.

The first step in starting a program of meter maintenance is to remove either the oldest meters from continuous service, or those meters that have the highest total registration. In this way, the system would benefit the most by getting its oldest meters removed from service, inspected, overhauled and tested.

The Meter Testing Installation

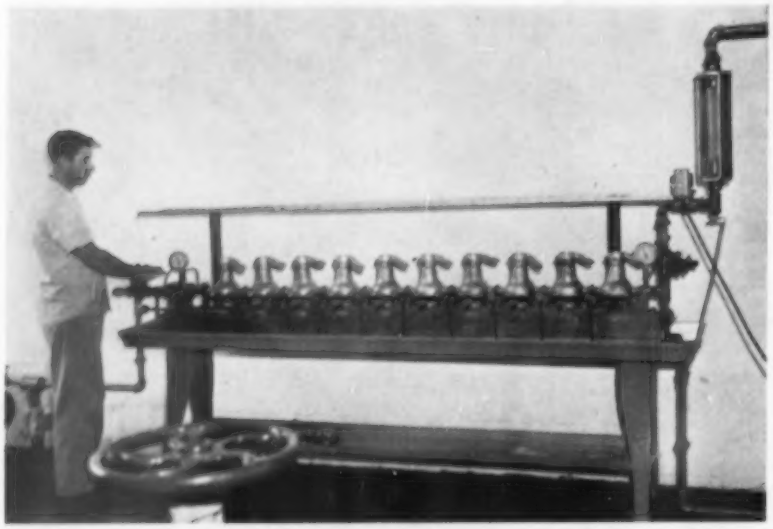
Now, before turning to a few comments on repairs something should be said about the equipment and facilities needed by the average small-sized system. The first requisite is to supply adequate space. This should be sufficient to house equipment properly without crowding. There should also be enough room for storage of repair parts as well as new and repaired meters.

In regard to the test branch, it is well to consider, even for the smallest type of shop, the advantages of a multiple testing unit where from four to ten small meters can be tested at one time. Again let me quote Mr. Sopp (Los Angeles Department of Water and Power) who stated that "an appreciable saving in time and effort can be gained [by multiple testing] over that of a single meter test bench operation.

Equipment for the test bench should include a 10-cubic foot or 100-gallon, and 1-cubic foot or 10-gallon, test tank and a test flow indicator. The low-flow indicator is generally considered essential to the proper control of the rate of flow passing through the meters during the testing procedure.

Other equipment for shop work should include some equipment for cleaning of meter cases; at least two adequate and sturdy work benches, preferably metal topped; one small bench for gear train and register repairs; a deep-set sink near the bench for washing parts; buffers; miscellaneous hand tools; dies; drills; etc. Mostly, this equipment is available at local hardware stores, or from meter manufacturers.

A portable meter should be available to prove to the consumer as well as yourself that an installed meter is running accurately. Portable meters usually can be connected to a sillcock or outside faucet, in order to check the meters in the pit or box. If you cannot afford to buy a portable, order a new meter from the manufacturer and state what you are going to use it for. I do not recommend this as a means of testing, as any error here through wear or dirt and sand will throw the service meter off. This field testing method does help public relations, and if the service meter does



CHESTER, PA.—Test bench of this meter shop is equipped with the latest type of electronic controls

not register close to the portable meter it can be taken in and tested on the bench.

Steps in Meter Repairing

It must be recognized that the demonstration of repair procedures is the best way to understand that meters can be effectively repaired without complicated equipment.

The steps called for in meter repair work, after the meter has been tested, begin in careful disassembly of the meter. Particular care should be given to the disc and chamber, since it is absolutely essential that they be properly repaired if high accuracy is to be obtained.

The disc chamber should be carefully cleaned. Special attention should be given to the gear train. All gears, spindles and bushings should be checked for wear. We recommend the gear train be disassembled whenever a meter is being repaired, if needed, the new parts should be added, and new bushings should be installed, as well as screws holding the train together. If the oil-enclosed type is used, individual gears may be substituted.

The stuffing box and register need careful attention, to assure that no binding action will cause accuracy to fall off, especially at the low flows. After all parts of the meter have been given necessary attention, and the meter is reassembled, testing after repair is necessary proof of workmanship. If the meter does not run accurately, then it was not repaired properly. Standards for meter performance after repairs are generally the same as those for new meters.

Payment for Meter Repairs

One of the questions that frequently arises in connection with a meter maintenance program is "Who should pay for the repairs?" This is an interesting question which has been answered more or less similarly by the operators of many water systems.

Typical of how this problem has been solved is a report from Kalamazoo, Michigan. Here is what Earl E. Norman, the manager of the City Light and Water Utilities reported:

"We operated under the plan of charging customers for meters and repairs and found that there could be no worse plan, relative to public relations. An extra charge of any kind, regardless of how justified it may be, irritates the public. We have, therefore, eliminated extra charges entirely.

"We feel that a public utility, whether it sells water, gas, electricity, or steam, and whether it is privately or publicly owned, should charge for the commodity sold, at the meter, and should make no other charges. We believe it should maintain at its own expense the metering devices and the distribution system up to the point of measurement."

Another aspect of the repair costs involved relates to the occasions when the customer is at fault. In many systems the customer, in such instances, is charged. Typical of this attitude is the procedure reported by the Board of Water Commissioners in Detroit. Here is what they say:

"On 2-inch and smaller meters we make all repairs, except those caused by customers's carelessness or lack of protection, such as frozen meters, recurrent damage by hot water, breakage by actions of owners or tenants, etc. We think this is equitable."

Experience with Meter Maintenance

In conclusion, I would like to report some experiences of maintenance programs in various parts of the country. Proven results are the most convincing arguments in any field, and they apply particularly in the water works industry.

Three years ago, the town of Winchester, Virginia, initiated a program of meter testing and repairing. At the last report, half of the town's 4,200 meters had been taken out and tested, overhauled and replaced.

This is what S. H. Reeves, superintendent of Water and Sewers had to say: "Our records show the program has increased revenue, in those areas where the project has been completed, by more than 14 per cent. Not only is our program paying for itself, but it is also substantially increasing the city's water revenue." That report is from a town of only 14,000 population.

A similar experience is reported from Green Bay, Wisconsin, a town of 46,000 population. A meter survey was conducted between the years 1937 and 1940, during which time 10,072 meters were repaired at a total cost of $21,115.

In 1936, before the survey started, 64 per cent of the 1,064 million gallons of water pumped was accounted-for, and $264,877 was received in revenue.

In 1940, the year the survey was completed, 81 per cent of the 1,066 million gallons pumped was accounted-for and $301,245 was received in revenue. These figures show that almost the same amount of water was pumped during the year before the survey started as was pumped the year it was completed. The same rates were in effect during both years, but the revenue received by the department was $36,367 greater in the year the test and repair program was consummated.

Thus, we see that in this Wisconsin city, the increased revenue during that one year more than paid for the cost of the entire meter test and repair program.

To sum up, it should be emphasized that this type of experience has been reported over and over again. Reports from all parts of the country confirm that effective maintenance procedures result in both curtailed water waste and in increased revenue for the water system.

Rubber-Lining a Large Reservoir

The unique application of 14,000 square yards of rubber sheeting to make a completely water-tight concrete reservoir

A Digest by JOHN FINCH
of a paper by A. G. McLellan, Engineer & General Manager, Sunderland and South Shields Water Company, England. Mr. McLellan's paper, titled "The Lining With Rubber of a Large Service Reservoir Damaged by Mining Subsidence," was presented at a meeting of the British Institution of Water Engineers.

A DESCRIPTION of one of the most unusual, but most effective, repairs to a reservoir damaged by subsidence as a result of coal-mining operations, *by lining with rubber*, is contained in a paper presented by A. G. McLellan to a meeting of the British Institute of Water Engineers. In his paper he states that "the chief interest lay not so much in the nature as in the magnitude of the task".

The Mill Hill reservoir of Newcastle Upon Tyne was of an orthodox design, having mass concrete walls and reinforced concrete floor and roof. Each of two construction instalments had dimensions of 360 feet long and 300 feet wide, with an 18-foot depth of water. A half-height division wall was included to allow for washing without interruption of supply. The walls were constructed in 50-foot lengths, between the contraction joints of crimped copper strip and asphalt. The floor was only lightly reinforced, and the roof was of beam-and-slab construction supported on square section reinforced concrete columns.

The first instalment in the construction incorporated an inlet and mixing chamber.

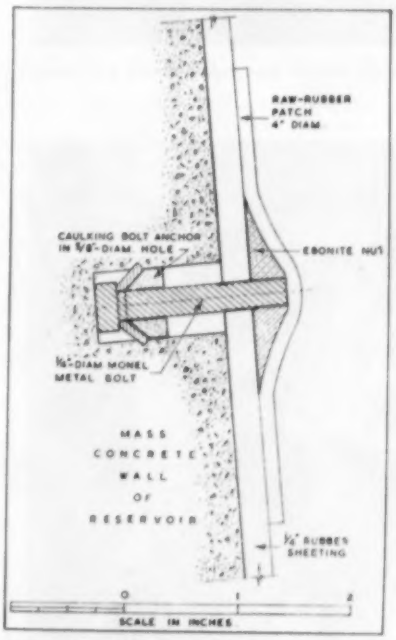
History of Reservoir Damage

In July, 1938, shortly before the completion of the second instalment, leakage developed through one of the wall contraction joints of No. 1 reservoir. This leakage was stopped by cement grouting, but started again in September. In spite of repeated groutings, by March 1939 leakage was at the rate of 0.35 mgd. Several wall joints had opened and cracks developed in the floor. From that time onward the development of cracks to a greater or lesser extent was continuous.

No. 2 reservoir was put into operation in March 1939, and by the following month it too was leaking. From then on, as in the case of the first reservoir, the history of the No. 2 reservoir was continuously one of grouting the constantly developing floor cracks and wall joint openings—in the belief that with the recession of coal extraction, the movement would cease.

Meanwhile and more serious from the point of view of structural stability of the reservoir, there existed the cumulative effect of the escaping water on foundations. Large cavities under the floor of No. 1 reservoir were caused by scouring away of pockets of sand under the clay foundations. The first of the pockets was found in 1942 and the latest in 1949 as a result of boring both in and around the reservoir. The cavities were filled with concrete and were grouted solid.

Although it was appreciated that repairs by cement grouting provided no permanent solution to the problem while movement was taking place, it was confidently assumed that the movement would gradually cease as the coal extraction receded from the site. This expectation, however, was not realized.



METHOD of fastening lining to reservoir wall and floor

Evolution of Rubber Lining

With the growing realization that no reliance could be placed on complete cessation of ground movement, an attempt was made to introduce a degree of articulation into the floor at those cracks which were repeatedly opening out. This work consisted of installing into the top floor layer, along the line of the crack, a narrow concrete panel having bitumen sheeting on its lower and vertical surfaces so that it could slide over the lower floor layer. Although this solution proved successful for the crack so treated, it obviously would not be the answer to cracks yet to develop in places which could not be forecast.

In 1948 an experiment was made with high-grade rubber strips, 2 feet wide by ⅜ inch thick, stuck to the concrete walls and floor over the line of the cracks. The experiment was most encouraging, and enabled this part of the reservoir to be used for almost seven years with a maximum leakage of only 7,000 gallons per day. However, the greatest difficulty was experienced in drying the concrete sufficiently to effect the seal with the rubber.

With the development of plastics, considerable experimental work was done in the reservoir with polythene sheets of varying thickness, but no satisfactory method of welding the sheets together could be evolved. It was but a simple step from this study to think in terms of rubber, although the cost of such an area of high-grade rubber was at first thought to be prohibitive.

However, each reservoir had cost pre-war approximately £75,000—and each might well cost £200,000 to con-

SPECIAL JOINTING precautions were necessary around pipe and dividing wall junctions with reservoir walls

INSTALLATION of rubber lining sheets was comparatively simple

struct at current costs; therefore, a substantial expenditure to restore utility of the reservoirs was considered justifiable.

Preliminary Stages in Lining

In 1950, technicians of the Dunlop Rubber Company were asked for their views on the project of complete lining of No. 2 reservoir with rubber sheet. The Company asked to be allowed to line a small area of one of the reservoir compartments: first, to determine whether the scheme was practicable; second, to develop a suitable technique; and third, to establish a suitable basis on which to quote for the work.

Accordingly, in 1951 an area of 90 square yards including a mitred wall junction, a 24-in. diameter pipe through the wall, a column base, etc., was chosen to be lined with rubber sheeting. As a result of this experiment it was decided that the project would be practicable, but that the relative humidity of the atmosphere inside the reservoir might, on occasion, be so high as to cause considerable delays in the progress of the work.

Before embarking on the full project, therefore, it was decided that the mixing chamber should be lined as a further experiment having amongst others the following advantages:

1. The repair of the mixing chamber was in any case an essential part of the repair work.
2. A water test could be carried out on completion of the work.
3. Tests for potential taste troubles could be made.

On the last point Mr. McLellan was particularly anxious, as the otherwise satisfactory solution of the problem might be wrecked by such a contingency.

This work on lining the mixing chamber was completed. It demonstrated the efficacy of the lining, and also the fact that the rubber did not impart any objectionable taste to the water.

Preparations for Lining a Reservoir

In May 1953, the Dunlop Rubber Company quoted for the lining of No. 2 Reservoir, based on the use of ¼ inch thick rubber sheet. The quotation provided for "standing time" when conditions in the reservoir might be too damp to allow making efficient rubber-to-rubber joints.

Heat drying was considered to be impracticable as a method of drying out the reservoir, and three wind sails were eventually rigged over and through the manholes. The efficiency

JOINTS between individual lining strips were covered by lapped patches rubber-cemented in place

of this means of drying was quite remarkable: as a result of these sails, no standing time was required. The speed in completion of the contract was attributable in no small measure to the use of this device.

The Dunlop Rubber Company's contract included the manufacture and delivery of the rubber together with its fixing, laying, and jointing, on surfaces to be prepared by the Water Company.

The preparation of walls and floors consisted of casting cylindrical concrete bases around all columns at their junction with the floor and at every other junction of a vertical obstruction with a horizontal surface; drilling the walls, and fixing 25,850 quarter-inch diameter Monel metal bolts in "Rawlplug" bolt anchors, then screeding to a smooth finish all uneven places in the floor.

Fixing and Laying the Rubber

The rubber was delivered in rolls, 4 feet wide by 25 feet long. It was unrolled down the wall surfaces and studded on to the bolts. Dome-shaped moulded ebonite nuts were screwed hand tight on to the base of the rubber. As shown in the drawings these nuts were shaped to accommodate 4-inch diameter rubber patches without presenting angular projections which might puncture these patches. The rubber sheets were long enough to run onto the floor itself; the top edge was located 4 inches above overflow level, and was held firmly against the wall by rubberized steel straps.

The floor rubber rested freely on the floor and was carefully "tailored" round all the cylindrical surfaces at column bases, etc. Nowhere on the floor or wall surfaces was the rubber made to adhere to the concrete, except on the surfaces of the column bases and pipe supports. All rubber sheets were butt jointed, and the joints were made with cold solution. The joint was finished with a rubber cover strap three inches wide.

It was thought that during the filling of the reservoir there might be a considerable volume of air trapped between the rubber and the concrete; that the trapped air might be forced to the division wall, and there tend to inflate part of the rubber covering. Accordingly air reliefs were provided.

After testing by means of a spark testing equipment, the reservoir was filled with water and was tested at progressively increasing depths until full. Complete water tightness was achieved.

While it is not possible to estimate the life of the rubber, it may conservatively be put at 20 years. The conditions existing in the reservoir are considered ideal for the preservation of rubber.

The total cost of lining the reservoir, excluding the mixing chamber, was £67,960. This total includes the supply of materials, £60,072; and preparatory work, £7,888. The total area of the lining is 14,660 square yards, and the work was completed in 20 weeks.

Camel in Ridgewood, N. J., Emphasizes Water Shortage

A traffic officer in Ridgewood, N. J., rubbed his eyes recently, when he saw a camel in town. There was no doubt about it: a camel was bearing down on him—right in the main street of the Village of Ridgewood.

The officer quickly sized up the situation. The camel, regardless of its reason for being where it was, had a perfect right to walk down the village main street.

The camel, led by its owner, lumbered up to the intersection and attempted to make a left turn. This presented a problem, because a sign expressly forbade a left-hand turn at the corner.

The animal had been hired from a children's zoo by the Action for Ridgewood Committee to dramatize the village's water shortage. It carried a sign reading:

"I can go without water, how about you?"

WATER WORKS PRACTICES

Coagulation

The Twenty-fifth of a Series

by GEORGE E. SYMONS, Ph.D.

Dr. Symons is Consultant and Technical Editor, Larchmont, N. Y. In this series he discusses *Water Works Practices* in the form of short course lectures. These are designed to assist plant operators, students, and all who wish to review fundamentals in this field.

THE PREVIOUS LECTURE, consisting of three parts, presented material on chemical handling and feeding; it contained a brief discussion of several processes wherein chemicals are used. One of these processes, coagulation, is extremely important in water works practice, particularly in the treatment of surface water supplies. This current lecture takes up the subject of coagulation in some detail.

A . . . Fundamentals

1 . . . Definitions

a. *Clarification* is the term applied to the removal of suspended and dispersed matter from water by means other than filtration.

(1) The term is often used to include both coagulation and sedimentation.

(2) The term is also applied to equipment which involves upflow passage of water through previously flocculated particles.

b. *Coagulant* is a chemical substance which, when added to water, will combine with certain substances, ordinarily present in water, and form a precipitate comprising floc particles, more or less gelatinous in character with a capacity to destabilize and remove suspended solids and some colloids from water.

c. *Coagulation* is a two phase process of mixing and flocculation to produce the destabilization and agglomeration of some colloids and all finely divided suspended matter by the addition to the water of an appropriate floc-forming chemical coagulant.

d. *Colloid* is the term applied to dispersed matter that will not settle under quiescent conditions, either because they are extremely finely divided or because they are stabilized by electric charge or solution links. (See Sol).

e. *Floc* is the term applied to the small gelatinous masses, formed in water by the addition of coagulants thereto, or by coalescence, agglomeration and binding together of colloids.

f. *Flocculation* is the term applied to the slow agitation of water containing a coagulant, to cause the growth of floc particles by collision, aggregation and coalescence of colloids and suspensoids. Flocculation is the second phase of coagulation.

g. *Mixing* is the first phase of coagulation and consists of a violent agitation of the water for the purpose of rapidly dispersing the dissolved coagulant.

MODERN flash mixer—Dorrco.

h. *Sedimentation* or settling is the process of subsidence and deposition, under the influence of gravity, of suspended matter carried by water.

i. *Sol* is the term applied to a liquid containing extremely finely divided particles dispersed as a colloid therein.

j. *Suspension* is the term applied to particles dispersed in water and prevented from settling by the movement of the water. Such particles will settle under quiescent conditions.

k. *Up-flow coagulation*, sometimes termed solids-contact clarification, is the process of making water, to which a coagulant has been added, flow upwards through a suspension or blanket of floc particles (sludge) previously formed.

l. *Coagulant aid*, is a material (usually a finely divided solid added to the water as an aid in floc formation and settling.

2 . . . Theory of Coagulation

a. Chemical coagulation involves complex reactions and equilibria between several variables, including the colloids in the water, the coagulant and the water itself.

b. The original theory of coagulation, now disproved, suggested that the gelatinous nature of the floc trapped colloids in its fluffy structure.

c. Modern theory explains coagulation as the destabilization of the sol by neutralization of the charge carried by the colloidal particles, thus breaking the solution link.

(1) Two types of colloids are important in coagulation: (a) turbidity and color in water and (b) colloids formed by the added coagulant.

(2) Turbidity and color colloids are negatively charged; coagulant colloids are hydrous oxides of iron or aluminum and are generally positively charged.

(3) Negatively charged colloids are destabilized by neutralization by the oppositely charged hydrous oxide colloids.

3 . . . Mechanism

a. Compounds of iron and aluminum ionize in water and produce cations and anions of high valence and will react with alkalinity to produce insoluble hydrous oxides.

(1) Positive cations destabilize the negatively charged colloids.

(2) Negative anions destabilize positively charged hydrous oxides of iron and aluminum.

b. Negative colloids (especially color) may be destabilized best at low pH values; hydrous oxides at higher pH values.

c. Rate of coagulation* depends on exchange capacity of the colloids removed; exchange capacity being the measure of the tendency for replacement of low-valence cations with cations of higher valence.

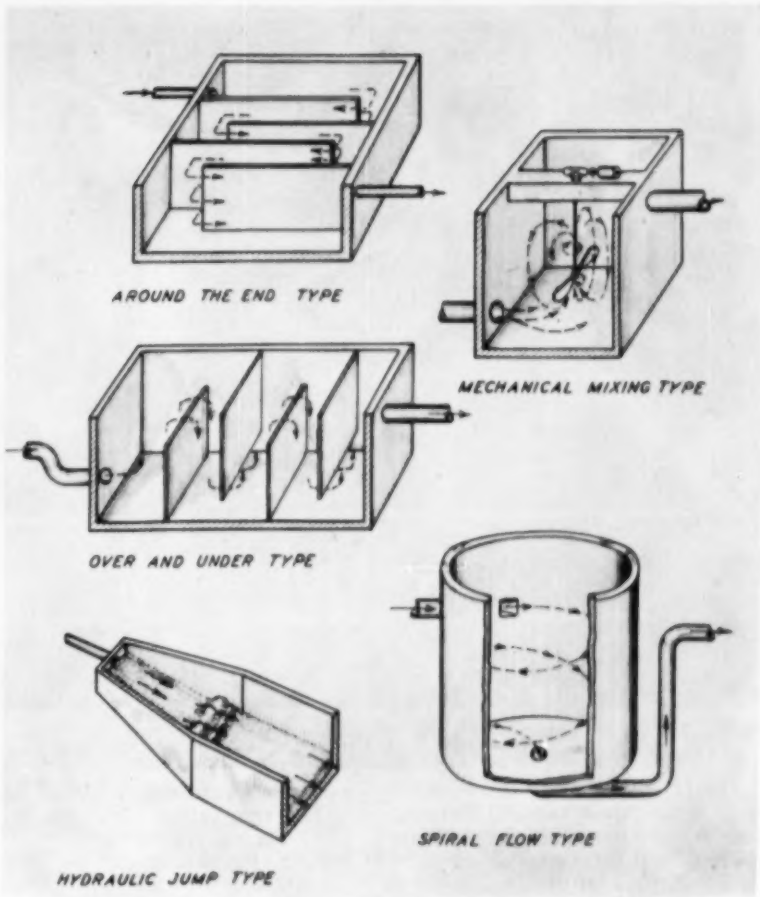
(1) When the exchange capacity is low, coagulation is slow unless a binding agent, such as a metal oxide is present. Hydrous oxides, being positively charged, interact with negative colloids and mutual coagulation results.

(2) When exchange capacity is high, a binder is less important and coagulation occurs due to the destabilization of the turbidity and color colloids.

(3) Exchange capacity is due to particles smaller than 1 mu (1/1000 mm) in diameter; if such particles are not naturally present, they should be added by using coagulant aids.

. . . Particles larger than 1 mu act as nuclei on which floc can grow.

d. Chemical reactions for coagulants are expressed most simply as follows:



MIXING CHAMBERS of older conventional types.

(1) Aluminum sulfate

$$Al_2(SO_4)_3 \cdot 14\,H_2O \rightleftarrows 2\,Al^{+++} + 3\,SO_4^{=} + 14\,H_2O$$
$$2\,Al^{+++} + 6\,OH^- \rightleftarrows Al_2O_3 \cdot x\,H_2O$$

. . . The hydroxyl ions (OH^-) must be supplied by natural alkalinity which, if insufficient, must be augmented by adding alkalies (lime, soda ash, etc.)

. . . For natural waters containing bicarbonate alkalinity, the reaction is expressed as follows:

$$Al_2(SO_4)_3 \cdot 14\,H_2O + 3\,Ca(HCO_3)_2 \rightarrow 3\,CaSO_4 + Al_2O_3 \cdot x\,H_2O + 6\,CO_2 + x\,H_2O$$

(2) Ferric iron salts are similar in reaction.

(3) Ferrous iron salts

$$FeSO_4 \rightleftarrows Fe^{++} + SO_4^{=}$$
$$Fe^{++} + 2\,OH^- \rightleftarrows FeO \cdot x\,H_2O$$
$$4\,FeO \cdot xx\,H_2O + O_2 \rightleftarrows 2\,Fe_2O_3 \cdot x\,H_2O$$

. . . For waters containing natural bicarbonate alkalinity the reaction is expressed as follows:

$$4\,FeSO_4 \cdot 7\,H_2O + 4\,Ca(HCO_3)_2 + O_2 \rightarrow 4\,CaSO_4 + 2\,Fe_2O_3 \cdot x\,H_2O + 8\,CO_2 + x\,H_2O$$

e. Formation of the hydrous oxide floc is best at certain pH values. The optimum range of pH values is known as the isoelectric range.

(1) For filter alum, this range may be from 5.5 to 7.4, depending on whether the water is soft and colored or moderately hard and moderately turbid.

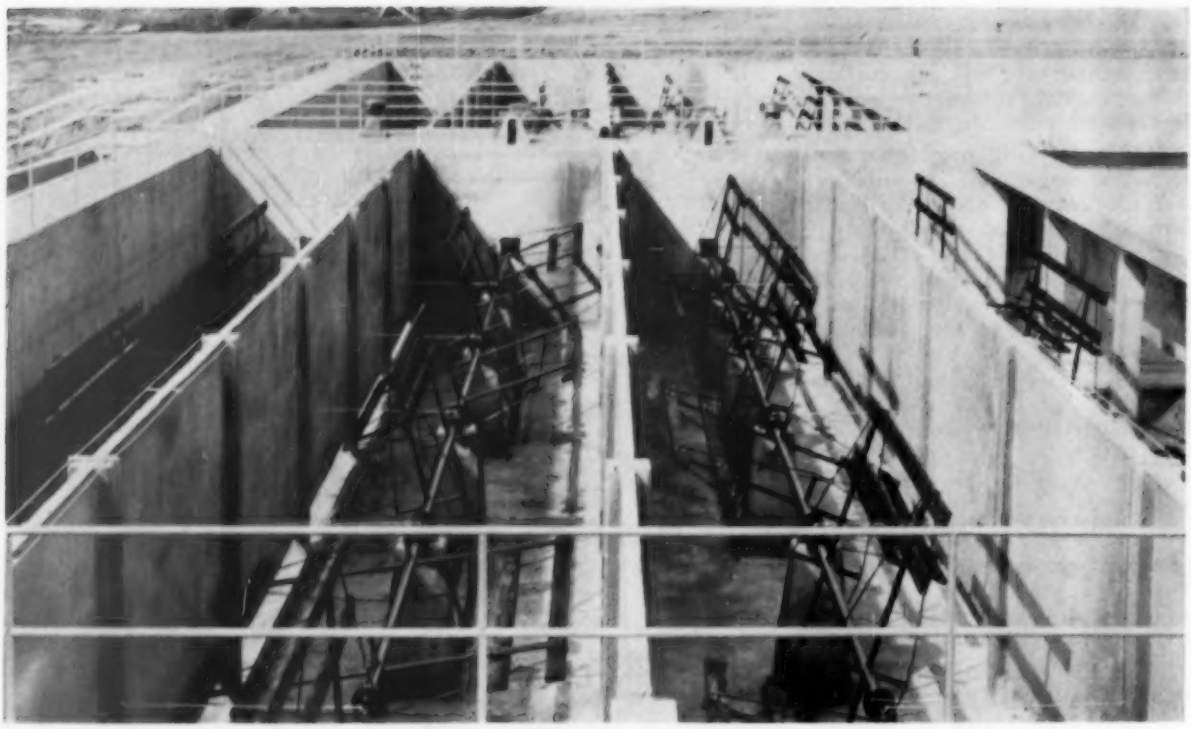
(2) Ferric iron salts will precipitate over a pH range from 4.0 upwards.

(3) Ferrous iron sulfate precipitates at a pH of 9.5 and up, but since the ferrous hydrous oxide is soluble below pH of 9.5, its usefulness can be extended by the presence of dissolved oxygen, which produces the hydrous ferric oxide at pH values down to 8.5.

4 . . . Need For Coagulation

a. Objectionable matter in raw water includes clay, silt, organic matter, color, algæ, and bacteria.

* Langlier, W. F.; Ludwig, H. F.; and Ludwig, R. G.—"Flocculation Phenomena in Turbid Water Clarification." Proc. ASCE, 78; Separate No. 118 (1952).



FLOCCULATOR of *rotating-paddle type*—**American Well Works.**

(1) If any of these exceed minimum limits, their removal is necessary to make the water acceptable for domestic and industrial use.

(2) Removal of these substances is effected by coagulation and sedimentation followed by filtration as a polishing treatment.

b. Coagulation, followed by sedimentation, reduces the load on sand filters, improves filter operation, and increases filter runs.

c. Coagulation may also be used in well supplies to reduce color, iron, and hydrogen sulfide.

5 . . . History

a. Modern coagulation practice in America began in 1885 at the Somerville-Raritan, N. J., Water Co. and became standard American practice following the classic experiments of Fuller and co-workers at Louisville, Ky., in 1895-97.

b. A review of this history of coagulation was presented in Lecture No. 2 of this series.

B . . . Coagulation Factors

1 . . . Factors Subject to Control

a. Choice of coagulant.

(1) Aluminum sulfate (filter alum)
(2) Aluminum sulfate, liquid
(3) Chlorinated copperas
(4) Ferric chloride
(5) Ferric sulfate
(6) Ferrous sulfate
(7) Sodium aluminate

b. Quantity of coagulant

(1) See previous lecture for notes on feeding.

(2) See Sect. D-1 of this lecture for notes on determining dosage and control.

c. Mixing and Flocculation Time

(1) As indicated previously in the discussion of theory, there are two phases of coagulation; quick mixing and slow flocculation.

(2) Regardless of concentration of coagulant, quick dispersion of the chemical throughout the water is a must. Violent agitation aids the quick dispersion and such mixing may be from 5 to 10 minutes; the more violent the action, the shorter the mixing time. Short violent agitation is termed "flash mixing."

(3) Flocculation time, like mixing time, is usually determined by the design of the plant and cannot be altered in operation.

. . . Flocculation is provided by slow mixing and depends on slow velocity of water movement which will promote collision of floc particles and consequent agglomeration.

. . . Modern plants usually provide flash mixing followed by 30 to 60 minutes of flocculation before sedimentation.

. . . Older plants provide coagulation periods from 10 to 90 minutes.

(4) In general, a relation exists between amount of coagulant added and the time necessary for optimum flocculation.

. . . The minimum quantity of coagulant for proper coagulation requires the maximum time for good floc formation.

. . . If twice the minimum required dosage is added, flocculation time is cut approximately in half; three times the minimum dosage will require less than half the maximum flocculation time but not as little as one third.

On the other hand an overdosage of coagulant will impede good flocculation in many waters.

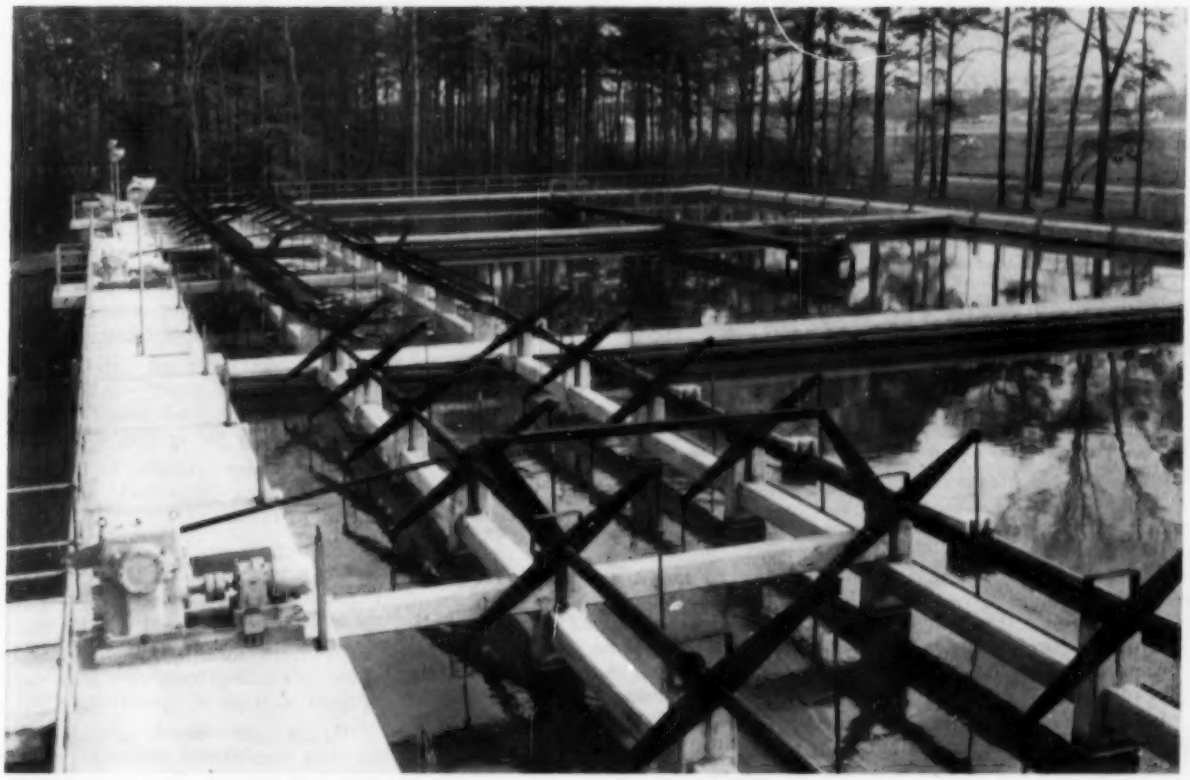
2 . . . Other Factors

a. Amount and character of impurity (turbidity, color, bacteria) affect the amount of coagulant required.

(1) Generally speaking, the greater the amount of impurities, the more coagulant required, but there is no direct relation between the two.

(2) Finely divided matter is more difficult to coagulate and requires more coagulant than coarse suspended matter.

b. Chemical characteristics of the water also affect the coagulant dose and the coagulation reaction.



WALKING-BEAM flocculator of churn type, imparts up and down motion—Stuart Corp.

(1) Alkalinity must be present in an amount sufficient to react with all of the coagulant added and leave a minimum amount of alkalinity after the reaction.

(2) The pH of the water (hydrogen ion concentration) is important to the coagulation reaction because of the isoelectric range of the coagulant as discussed above. Adjustment through the addition of alkalies or acids may be required.

c. Temperature of the water has a direct effect on the rate of good floc formation.

(1) The colder the water, the slower the rate of floc formation. Water near freezing temperature often requires two to three times as long to coagulate as water near 20°C.

(2) Addition of greater coagulant dosages tends to offset the effect of low temperature, but this relation must be determined by trial.

d. Violence of agitation is desired for rapid mixing but is undesirable in subsequent flocculation.

(1) In flocculation basins velocities of 1.0 to 1.3 ft per sec are common.

(2) This velocity is typical of baffled basins and movement of rotating paddles and walking-beam type flocculators.

(3) Higher rates of movement tend to break up or prevent floc growth, except perhaps in straight conduits and circular basins.

C . . . Coagulation Aids

1 . . . Artificial Nuclei

a. Suspended solids in water aid in initial floc formation by providing nuclei on which floc can grow.

b. If suspended matter is not present, nuclei may be provided by adding finely divided solids:

(1) Clay
(2) Fuller's earth
(3) Bentonite
(4) Activated carbon

2 . . . Solids-Contact

a. In lieu of artificial nuclei, return of a portion of previously settled sludge solids to the coagulation basin will provide nuclei for further floc formation.

b. Mechanical rotating paddles at the entrance of flocculation basins, revolve in a manner to pick up the first floc to settle and return it to the water.

c. Up-flow clarifiers are mechanical devices or tanks constructed to provide intimate contact of coagulant and raw water with previously formed floc by passing incoming water and coagulant upward through a sludge blanket.

(1) Up-flow coagulation provides more complete and more rapid chemical reaction, and produces larger, heavier and better solid particles.

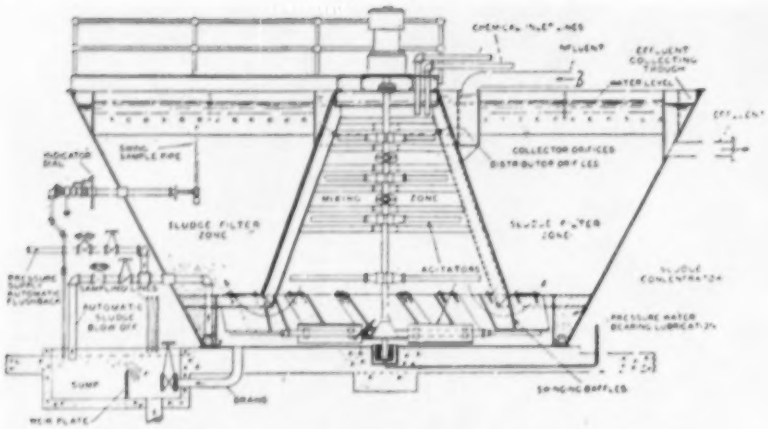
(2) Up-flow clarifiers also provide for the rapid separation of solids from water within the device and the total time required for coagulation and clarification (separation) is much less than that required for coagulation and sedimentation in conventional flocculation and sedimentation units.

(3) Inasmuch as this device involves clarification or removal of solids from water as does sedimentation, the design and operation of these devices will be discussed more fully in the lecture on "Sedimentation."

3 . . . Activated Silica

a. Activated silica is a negatively charged colloidal particle formed by the reaction of a dilute sodium silicate solution with an acidic substance or other activant.

(1) Activated silica is not a chemical in the ordinary sense of the word, it is a colloidal micelle designated by the formula, $^{-}SiO_2^{-}$, which is formed and exists only when solutions of sodium silicate and an acti-



UP-FLOW type combination mixing, flocculation and clarification basin—Permutit Co.

vating chemical are mixed in proper proportions.

(2) The life of the micelle and its effectiveness depend on the maintenance of certain limits of concentration of chemical solutions used and concentration of the resultant solution formed.

b. Activated silica has transitory characteristics but it has certain qualities which make it an excellent coagulation aid.

(1) Activated silica micelles act as nuclei around which floc will form; it attracts floc nuclei and produces a heavy, dense, tough floc.

(2) These qualities are most evident when activated silica is used within certain limits of concentration after its production.

c. Activated silica can be prepared by batch or continuous process.

(1) Chemicals used as activating agents are: alum, ammonium sulfate, carbon dioxide, chlorine, sodium bicarbonate, sodium aluminate, and sulfuric acid.

(2) Baylis at Chicago and Graf and Schworm in St. Louis pioneered the development in the 1930's, the former with sulfuric acid, the latter with filter alum. Both used batch preparation.

(3) Sodium silicate used for preparation of activated silica is 41° Be′, containing 8.9 per cent Na_2O; 28.7 per cent SiO_2; 62.4 per cent water. It weighs 11.6 lb. per gal and is sold by Philadelphia Quartz Co. as "N" Brand silicate. Other brands and concentrations can be used.

(4) An important factor in the use of activated silica is the controlled aging of the sol to prevent gel formation and consequent plugging of the equipment.

(5) Continuous preparation of silica sol was first tried in 1946 but was, in reality, a method of continuous batching, not continuous activation.

... About 1950 chemical feeder manufacturers began developments of continuous activators; one device is limited to chlorine as the activating agent, the other can use any activating agent and has built-in control of aging times and concentrations to prevent gel formation plus automatic flushing in case of failure of activant or silicate flow.

d. Beneficial effects of activated silica as a coagulation aid include:

(1) Improved clarification and color removal in shorter periods with lower dosages of coagulant.

... This means that smaller coagulation basins can be used or that the capacity of present basins can be effectively increased, or at least the designed capacity can be attained at peak loads. Capacity increases up to 25 per cent have been reported.

... Lower coagulant dosages with concurrent reductions in chemical costs of 30 to 50 per cent have been reported.

(2) Floc formation in cold water and in low turbidity water is improved with activated silica.

(3) Longer filter runs are possible (increases up to 35 per cent) and the amount of filter wash water may be reduced by 25 per cent.

(4) In water softening and in iron and manganese removal, improved operation results.

(5) Denser sludge is produced where activated silica is used, thus requiring smaller sludge capacity in the settling tanks.

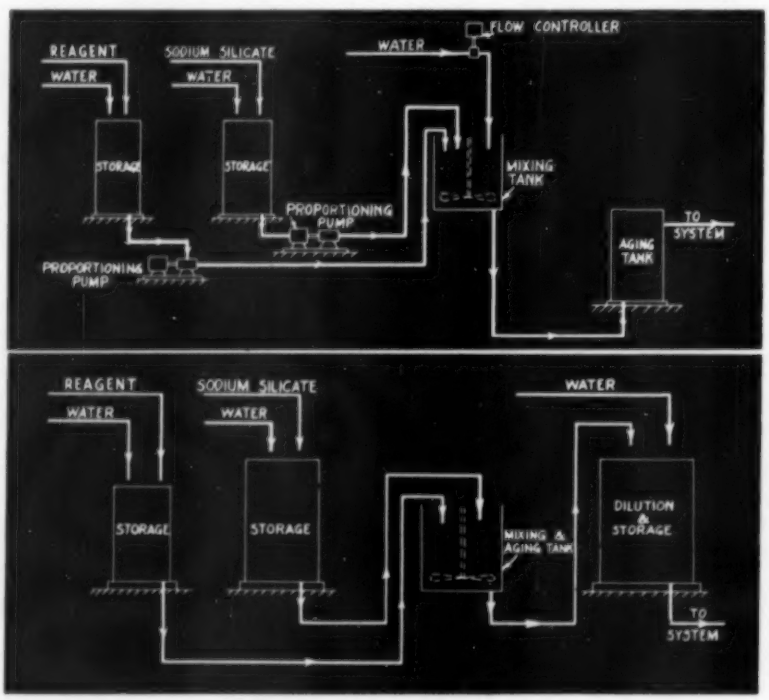
(6) With up-flow clarifiers, activated silica improves operation and permits increase of operating rates.

(7) In some waters, activated silica has been used effectively as a coagulant without alum or iron salts.

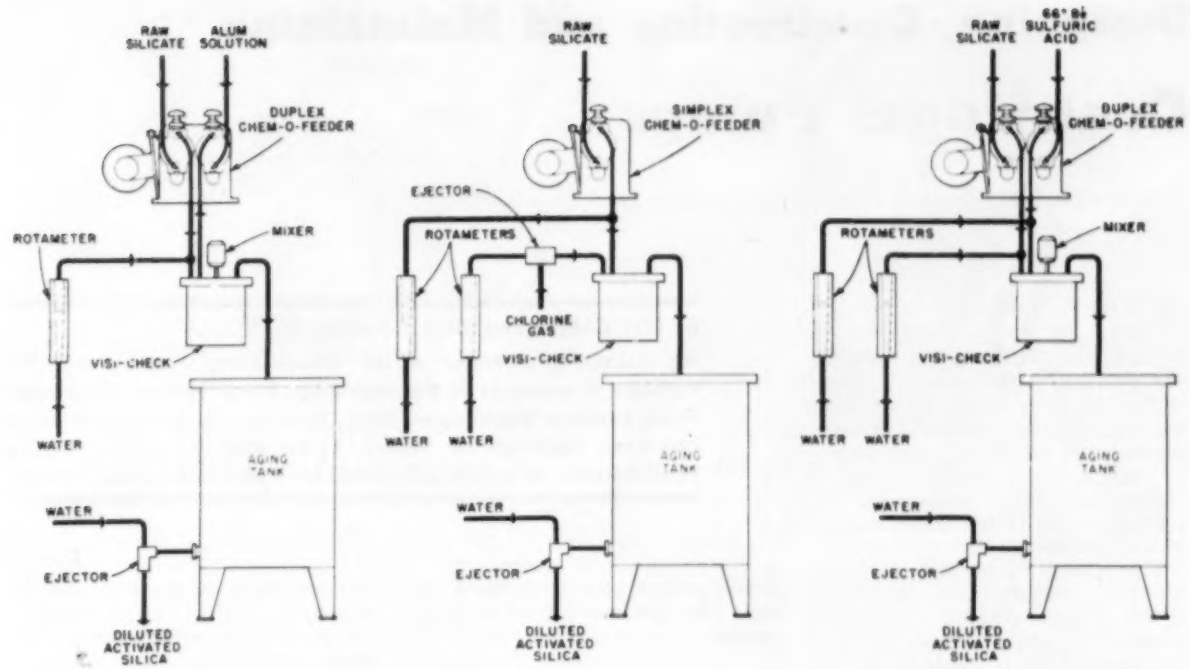
D ... Coagulation Practice

1 ... Control

a. The amount of coagulant required varies over a wide range (from



ACTIVATED SILICA production flow diagrams.



SILICA ACTIVATORS for alum, chlorine or acid activation.

1 to 100 ppm or more) and depends on the particular water being treated.

b. The amount of activated silica required as a coagulant aid varies from 4 to 20 ppm, with dosages being under 10 ppm.

c. Determination of the required coagulant dose is done most easily by trial using the "Jar Test Procedure."

(1) Equipment for the Jar Test includes a multiple laboratory stirrer, with two quart square mason jars, plus graduates, pipettes, flasks, funnels, and other simple laboratory apparatus.

(2) Stock reagent solutions of the plant chemicals are made in concentrations to make dosage calculations simple by adding definite volumes of solution to the water under test.

(3) Amounts of coagulant reagent are added to the test jars, each jar receiving a greater dose than the previous sample. All jars should be dosed quickly and with a minimum time interval between jars.

(4) The dosed samples are mixed quickly and then stirred slowly for 15 minutes, after which they are allowed to stand quiescent for 30 minutes.

(5) That jar which shows the best flocculation and best clarification represents the optimum dose. Results of jar tests must be correlated with plant practice as they often cannot be transferred directly to plant operation.

(6) Specific and detailed directions for Jar Test Procedures are given on page 97 of the June 1955 Reference and Data Edition of *Water & Sewage Works.*

c. Control of dosage and feed rate in accord with process requirements was outlined in Parts 2 and 3 of the previous lecture (See Chemical Handling and Feeding).

2 . . . Application

a. The point of addition of coagulant and/or coagulant aid with respect to other chemicals may vary from one plant to the next.

(1) For waters low in alkalinity, lime is added before the alum; the same is true where lime and ferrous sulfate (copperas) are used.

(2) In some instances pre-chlorination reduces the amount of coagulant required; in other cases the reverse situation is true.

(3) Activated silica sol generally should be added ahead of other chemicals, but this may not always be the case.

(4) Activated carbon added ahead of coagulants may improve floc formation by providing the nuclei mentioned heretofore.

(5) There is no set rule for sequence of chemical additions. Experimental determination is desirable for each water plant and in some instances the sequence may vary with changes in water supply character.

b. Modern practice calls for maximum benefits from coagulation and sedimentation in order to reduce the load on filters, extend filter runs, and reduce filter washing operations and costs. In short, preparation of the water for filtration is a most important step and coagulation is vital to that preparation and should be given careful consideration, diligent operator attention and intelligent analytical control.

E . . . References

Material for this lecture was based on current technical literature and several reference texts including:

AWWA—"Manual of Water Quality and Treatment," 2nd Ed.

Buswell, A. M.; "The Chemistry of Water and Sewage Treatment" (Chem. Cat. Co.).

Fair and Geyer; "Water Supply and Waste-Water Disposal (John Wiley & Sons).

Next Lecture — Sedimentation.

Designing, Constructing and Maintaining Centrifugal Pumps

Part 8—Stuffing Boxes, Packing and Glands

by ROY CARTER and IGOR J. KARASSIK

Mr. Carter is manager of the Volute Pump Section, and Mr. Karassik is manager of the Multistage Pump Section, Centrifugal Pump Division, Worthington Corp., Harrison, N. J. This new series has been prepared by Messrs. Carter and Karassik to review characteristics of centrifugal pumps for water and sewage service.

A STUFFING box of a centrifugal pump has one function, that of packing the shaft against leakage where it passes through the casing. With a pump operating with a positive suction head this would be leakage of liquid out of the pump, whereas with a pump operating with a suction head below atmospheric the function would be to prevent leakage of air into the pump.

For general service pumps a stuffing box generally takes the form shown in Figs. 1 and 2. Basically it consists of a cylindrical recess around the shaft or shaft sleeve to accommodate a number of rings of packing.

Where it is desired to seal the box, a lantern ring or seal cage (as in Figs. 3 and 4) generally separating the rings of packing into approximately equal sections is used. The packing is compressed to give the desired fit on the shaft or sleeve by a gland capable of axial adjustment. The bottom of the box may be the pump casing (as in Fig. 2), a throat bushing (as in Fig. 1), or a bottoming ring (Fig. 3).

Throat bushings are used mainly on smaller pumps with axial split casings, primarily for manufacturing reasons. In such small pumps an integrally formed stuffing box throat limits the size of the boring bar used to machine the casing internally to a smaller size than when a throat bushing is used. Hence the need to use the throat bushing design for such smaller pumps with axially split casings. They are rarely used on larger pumps.

Seal Cages

When a pump operates with a negative suction head, the inner end of the stuffing box is under a vacuum and air will tend to leak into the pump. For those conditions it is usual to have the packaging in two sections, separated as shown in Figs. 1, 2, and 3 by lantern rings or seal cages. Into the space provided by the seal cage, water or other sealing medium is introduced under pressure, causing a flow of sealing medium in both directions. This construction also is useful on pumps handling inflammable or chemically active and dangerous liquids to prevent the outflow of the pumped liquid.

In pumps handling clean cool water, the stuffing boxes are usually sealed by water taken from the pump discharge or, in the case of multistage pumps, from some intermediate stage. The stuffing boxes should be supplied with sealing water from an independent clean, cool supply under the following conditions:

1. When a high suction lift (over about 15 feet) or vacuum exists.

2. When discharge pressure will be less than 10 psi.

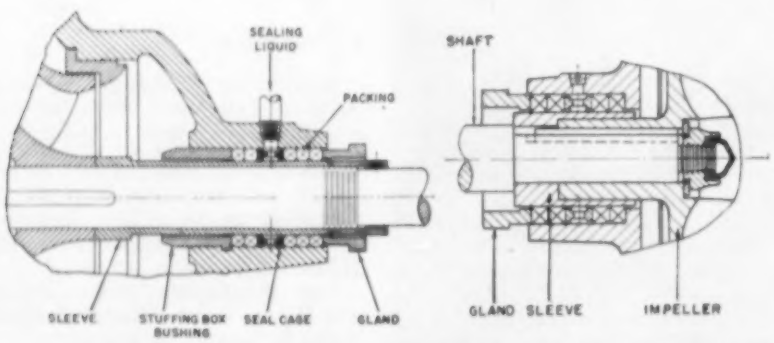
3. When the pump is handling hot water and adequate cooling is not otherwise provided.

4. When the water is muddy, sandy or gritty.

5. When the liquid handled is other than water (such as juice, sticky liquids, etc.) and no special provision is made in the stuffing box design for the liquid being pumped.

It is sometimes advantageous to locate the seal cage with most of the packing on one side. For example, locating the seal cage as in Fig. 5 would be desirable for a pump handling gritty water, as it would favor a greater proportion of the sealing liquid going into the pump, thus keeping grit from working into the box. Fig. 6 shows most of the rings between the cage and the inner end of the box. Such an arrangement would be applied where little dilution of the liquid being pumped is desirable.

Where clean, cool water is not available, grease or oil seals are often used, for example in drainage, irrigation and sewage pumps. Most pumps for the last service have a single stuffing box subject to discharge pressure and usually are located so they have a flooded suction. It is therefore not usually necessary to seal the boxes of such pumps



CONVENTIONAL stuffing box with throat bushing (Fig. 1, left) and without throat bushing (Fig. 2, right)

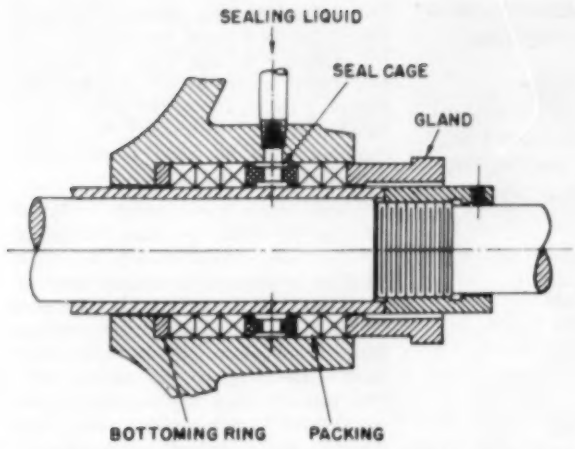


Fig. 3—CONVENTIONAL stuffing box with bottoming ring

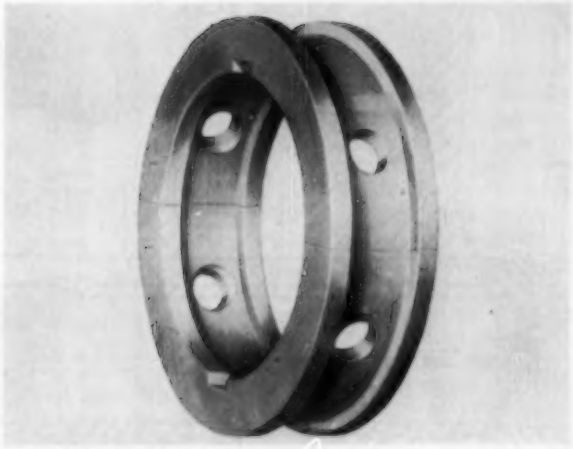


Fig. 4—LANTERN gland or seal cage

against air leakage, but the forcing of grease into the sealing space and the packing is somewhat of a help in excluding grit.

For sewage pumps there is on the market an automatic oil sealer which exerts discharge pressure on one side of a plunger in a cylinder with oil or light grease on the other side. The oil or grease under pressure is connected to the seal connection, thus subjecting it to near discharge pressure. As the inner end of the stuffing box would be subject to about 80 percent discharge pressure, this results in a slow flow of grease or oil into the pump when the unit is in operation and no flow when it is out of service.

Some pumps handle water in which there are small, even microscopic solids. Using such water as a sealing medium introduces these solids into the leakage path, with resulting short life of the packing and sleeves. In some such cases it is possible to remove these solids by use of small pressure filters in the sealing water piping from the volute to the stuffing box.

Water Cooled Stuffing Boxes

The problem of maintaining the packing in a stuffing box is made more difficult with high temperatures or high pressures. Pumps handling hot liquids or having stuffing boxes subjected to high pressures are generally provided with water jackets to which cooling water is supplied. This cooling water removes the heat from the liquid leaking through the stuffing box as well as the heat generated by friction in the stuffing box, thus improving the conditions under which the packing has to operate. (In some special cases, oil or gasoline may be used in the cooling jackets instead of water.)

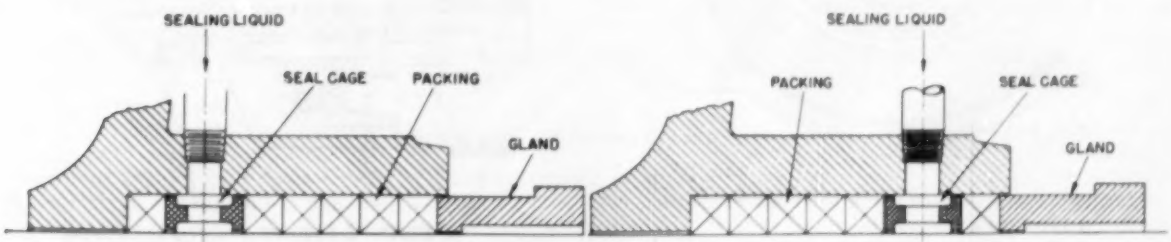
Two different methods are available for the construction of water cooled stuffing boxes. The first, illustrated in Fig. 7, consists of providing cored passages in the casing casting itself. These passages, which surround the stuffing box, are arranged with in-and-out connections. The second uses a separate cooling chamber combined with the stuffing box proper, the whole assembly being inserted into and bolted to the pump casing, as in Fig. 8. The choice between the two is made principally on the basis of individual manufacturing preferences.

Of course, the limiting pressure and temperature conditions against which it may be possible to pack a stuffing box vary with the type of pump in question, as it may not be economical to equip a pump normally intended for moderate service conditions with an expensive type of stuffing box for the infrequent application when such a construction would be needed. Therefore, whenever the limitations imposed by the manufacturer on the stuffing box conditions for a given pump are exceeded, the only solution resides in the application of pressure reducing devices ahead of the stuffing box proper.

Since the design of such devices has now reached a high degree of proficiency, the only drawback to their application is the necessity of bleeding a part of the effective capacity of the pump back to a lower pressure level and the resultant reduction in the efficiency of the installation.

Pressure Reducing Devices

Essentially, pressure reducing devices consist of a bushing or a meshing labyrinth located between the pump interior and the stuffing box proper and ending in a relief chamber. The latter is connected to some point in the installation where a suitably low pressure is established and the leakage past the pressure device



RECOMMENDED location of seal cage for dirty water (Fig. 5, left) and where little dilution of liquid is desired (Fig. 6, right)

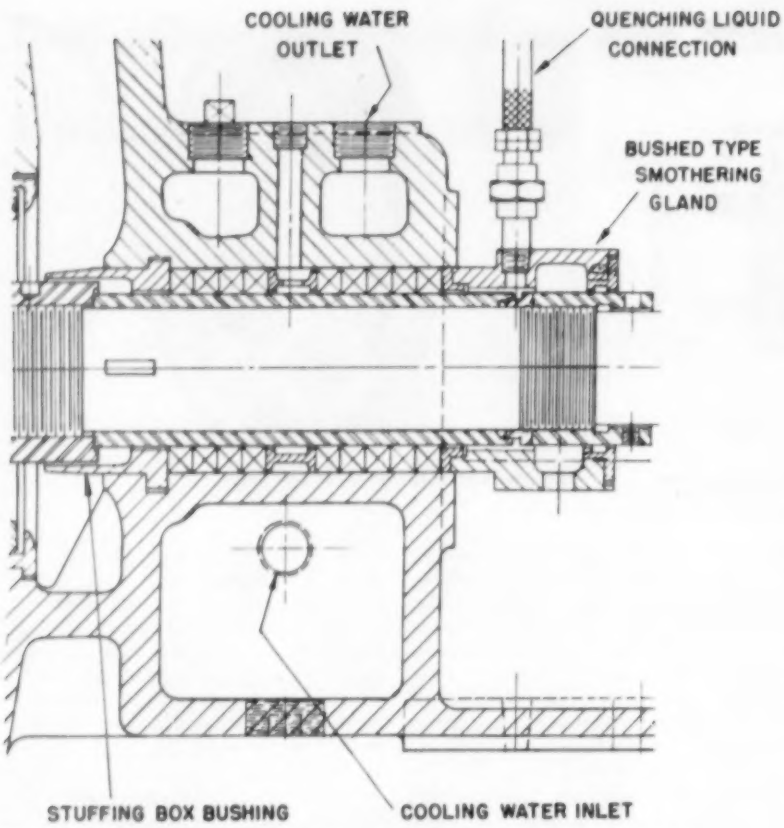


Fig. 7—WATER-COOLED stuffing box with cored water passage cast in casing

is returned to this point. When the liquid pumped must be salvaged, as for instance in the case of treated feedwater, it is returned back into the pumping cycle. If, on the other hand, the liquid can be wasted, the relief chamber may be most conveniently connected to a drain.

There are a great many different designs of these pressure reducing devices. The design shown in Fig. 8 involves a pressure reducing element consisting of a removable serrated bushing separating the high-pressure liquid from a lower-pressure chamber on the inner end of the stuffing box. The leakage past the serrated bushing is bled to a lower-pressure point through the bleed-off connection.

When relatively high pressures on stuffing boxes are encountered, labyrinths of the intermeshing type may be located ahead of the stuffing box. They likewise may be located on the discharge side, where they follow the balancing device and precede the stuffing box. It should be noted that the piping from the leakoff chamber following such pressure reducing devices should be amply sized so that as wear takes place and leakage increases there will not be an appreciable increase of friction in the leakoff piping and a subsequent increase of the pressure at the stuffing box.

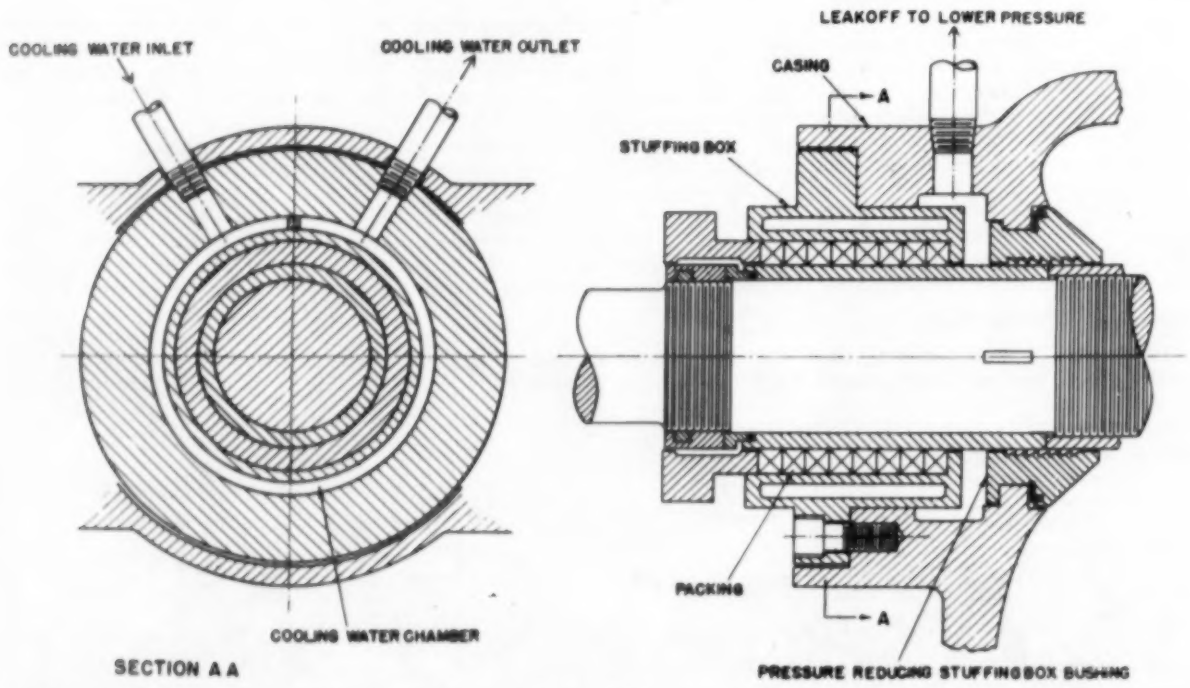


Fig. 8—SEPARATE water-cooled stuffing box for insertion in casing in pump having pressure-reducing stuffing box bushing

Stuffing Box Packing and Glands

There are numerous types and materials of stuffing box packing, each especially adapted to some particular class of service. Some of the principal types are as follows:

1. Graphited asbestos packing is comparatively soft and is suitable for cold water and hot water applications in the lower temperature range. This packing is generally supplied in continuous coils of square cross-section and in various sizes. To be made ready for use, it is cut off from the coil in lengths to make individual rings. The ends are cut at a slight angle with a slight clearance to provide for expansion so as to prevent "buckling". This packing is good for general service under normal pressures and is the most commonly used. For pressures beyond 200 psi this packing is not suitable except at very moderate rubbing speeds.

2. Metallic packing rings are composed of flexible metallic foil with graphite lubricant and are squared to the proper size. This packing is self-lubricating for its starting-up period, as the foil is impregnated with oil and graphite under compression, permitting the oil to flow to the surface of the moving shaft or sleeve. The foils are made of various kinds of materials such as babbitt, aluminum, copper, etc. Babbitt foil is used for low and medium temperatures on water and oils (up to 450° F) and medium to high pressures. Copper is used for medium to high temperatures and pressure on water and low sulfur content oils. Aluminum is mainly used on oil service, also for medium to high pressures and temperatures.

Standard practice is to obtain metallic packing in ring rather than coil form, die-molded to exact size. For best results, the shafts or hardened sleeves, which are preferred, should be in perfect alignment and concentric with the axis of rotation, should operate without vibration, and should be highly polished.

The choice of the material of the shaft or shaft sleeves is extremely important to the life and maintenance of metallic packing. Some packing sets are often made in combinations of alternating hard and soft rings, giving very good results.

Many other types of packing are commonly furnished to meet customers' special specifications, such as hemp, cord, braided type, duck fabric, chevron type, and others too numerous to mention.

Stuffing box glands may assume several forms, but basically they can be classified into two groups: (a) solid glands and (b) split glands.

Fig. 9—SPLIT-type gland

Split glands are made in halves so that they may be removed from the shaft without dismantling the pump to provide more working space when the stuffing boxes are being repacked. They are desirable on pumps that have to be repacked frequently, especially if the space between the box and the bearing is too restricted. The halves of split glands are generally held together by bolts, as illustrated in Fig. 9, although other designs are also used.

In a great many applications, the stuffing box leakage, if permitted to issue unimpeded into the atmosphere, could give rise to serious inconveniences if not actual danger to the operating personnel. This is frequently the case with centrifugal pumps handling liquids such as hydrocarbons at temperatures above their flash point or vaporizing temperatures.

As this leakage in some cases cannot be cooled sufficiently by the application of a water-cooled stuffing box, smothering glands (Fig. 7) are used. In such a gland provision is made in the gland itself to introduce a quenching liquid (either water or another hydrocarbon at low temperature), which mixes intimately with the leakage, lowering its temperature or, in the case of volatile liquids, absorbing this leakage.

Stuffing box glands are generally made of bronze, although cast iron or steel may be used for all iron fitted pumps. Where used for refinery service when the fluid pumped may give off inflammable vapors which may ignite from sparks generated between the gland and the shaft or sleeve if both are made of ferrous metal, iron or steel glands are generally bushed as shown in Fig. 7 with a non-sparking material, such as bronze.

Maintenance Of Stuffing Boxes

The maintenance of stuffing boxes is primarily concerned with replacing the packing when necessary. While this sounds simple, it must be done correctly or the results will be not satisfactory. The steps involved are as follows:

1. Never try to add one or two rings to the old packing. It is false economy. Remove the old packing completely, using a packing puller if available, and clean the box thoroughly. Inspect the sleeve to make sure it is in acceptable condition. Putting new packing in a box against a rough or badly worn sleeve will not give satisfactory service.

2. Check that the new packing is a proper type for the liquid, operating pressure and temperature. Unless the packing comes preformed in sets, make sure that each ring is cut square on a mandrel of correct size.

3. Insert each ring of packing separately, pushing it squarely into the box and firmly seating it by using two half rings of proper length to properly fit the box. Successive rings of packing should be staggered so the joints are 120° or 180° apart.

4. When a seal cage is involved, make sure it is installed between the proper two rings of packing so it will be located properly for the sealing liquid supply when the box is fully packed and adjusted.

5. After all the required rings of packing have been inserted, install the gland and tighten the gland nuts firmly. In doing so, watch that the gland enters the stuffing box squarely and without cocking, so the full periphery of the packing is uniformly subjected to pressure.

6. After this first tightening of the gland, back off the nuts until they are merely finger tight. When ready, start the pump keeping the gland loose so there is excessive leakage initially. Occasionally tighten up slightly and evenly on the gland nuts, maybe at 15- or 20-minute intervals, so the leakage is reduced to normal after several hours.

Do not attempt to reduce the leakage to drops. It must be a steady stream sufficient to carry away the heat generated by the packing friction. Unless the stream of liquid leaking through the box is sufficient to remove this heat, the packing will be burned and the sleeve scored. (On pumps with quenching glands, stop the supply of quenching water at intervals, and observe the actual leakage through the box.)

Repacking and adjusting of stuffing boxes should only be done by experienced personnel. If those not so experienced must do the job, they should be cautioned against too much pressure on the glands and it should be made clear to them that excessive leakage is not as sinful as too little.

Compressed Air in Water Works

by EDMOND C. POWERS

Mr. Powers is Educational Director of the Compressed Air and Gas Institute, Cleveland, Ohio. In this article he briefly describes several of the important applications of compressed air in water pumping and treatment. The photographs and data were furnished through the courtesy of the Institute.

THE APPLICATIONS of compressed air in water pumping stations and treatment plants until recently have been limited. Although not completely incongruous in the average water works, compressors nevertheless have occupied a relatively minor position among the pumping stations' components.

With the exception of maintenance functions and those water works using air lift pumps, the need for compressed air was confined to pipe testing, caulking operations, and minor control systems that required one or two small capacity, light duty compressors of perhaps 0.5-horsepower each.

Now, however, the ever-increasing recognition of compressed air as a safe, simple, and dependable mode of power has caused its application to spread throughout the entire pumping station, enveloping control devices of all types, aerating systems, soot blowing, and a host of other associated water works activities. A few of these applications are briefly reviewed here to show what compressed air can do better and cheaper for the water works operator.

Air Lift Pumping

If air lift pumping is not the oldest compressed air application in the water works, it certainly must be close to the oldest such application. Successfully used for many years in a number of stations, this unit is by no means obsolete. It still finds wide acceptance in deepwell areas where long-shafted vertical turbine and submersible wet pit pumps are impractical or uneconomical.

Its chief advantages are that it has no submerged wearing parts to be affected by abrasives suspended in the water, and crooked well shafts do not materially affect its operation. Water contamination by the pumping medium is practically nil, thereby reducing the filtration and purification requirements to a slight degree.

Furthermore, because the power source is centralized and may consist of a single compressor and motor to handle a group of wells, installation costs are lower. On the other hand, to provide an individual mechanical pump and motor for each well of a field sometimes results in numerous substations a considerable distance from each other. With air lift pumps and a centralized power source, accessibility and maintenance problems are simplified.

Aeration Uses

Where aeration figures prominently in conditioning the water, compressed air offers real possibilities.

Two of the more important considerations in efficient aeration are (a) the amount of air-water surface, and (b) the duration of the air-water contact time. Since air at a given pressure can be made to pass through smaller pipe openings than water at the same pressure, the air can be broken up into countless small bubbles that will present a maximum air-water surface ratio. Of additional importance is the fact that an air bubble will require a longer time to reach the liquid surface than will a sprayed water droplet to fall back to the water. The contact time between the water and air, therefore, is increased substantially, providing better aeration. The obvious advantages of control pressure variation in such a system immediately open up new possibilities in aeration control.

It is conceded that the greater the air pressure, the greater will be the volume of air flow. But greater air flow also means increased aeration taking place. If, then, instruments could be used to periodically measure the condition of the water, automatic control of aeration could be achieved. On dictation by the instrument measuring the condition of the water, the volume of air for aeration could be varied to meet the immediate requirements of the water conditioning system.

In many instances severely cold weather will influence spray-type aeration systems to such an extent that the use of compressed air is an absolute necessity if aeration is to retain its efficiency. Seasonal and perhaps daily changes in aeration requirements are easily handled with compressed air.

$$T = \frac{V\,(P_1 - P_2)}{C\,P_0}$$

- T = Time receiver will supply air from upper to lower pressure limits, in minutes.
- V = Volume of receiver, in cubic feet.
- P_0 = Atmospheric pressure, in pounds per square inch absolute.
- P_1 = Maximum tank pressure (compressor discharge pressure), in pounds per square inch absolute.
- P_2 = Minimum tank pressure (pressure required to operate tool), in pounds per square inch absolute.
- C = Air required (from study of load cycle), in cubic feet per minute.

Fig. 1—PROTECTION provided by compressed air system in event of power outage

Filter Cleaning

Filter beds, too, can be reactivated faster by means of air under pressure. Speed of reactivation is a vital factor in the warm months when water consumption is at its peak and the shutdown time of a filter bed for cleaning must be at a minimum.

Low-pressure air for agitation of the sand will reduce backwash time considerably. The same air system that is used for maintenance can be used here also. It only becomes necessary to install pressure regulating valves immediately before the air distribution pipes in the filter beds. A reduction of the air pressure to about

10 pounds per square inch is adequate in most plants.

With a cleaning pressure of 10 pounds per square inch, and a plant air system with a pressure of 100 pounds per square inch, only a small air receiver is required to store sufficient air for a cleaning cycle. For instance, a 90 cubic foot receiver holding air at 100 pounds per square inch would supply approximately 420 cubic feet of air at 10 pounds per square inch.

This ability of the compressed air system to store up power by means of air receivers is one of its most outstanding features. Extra large storage tanks can provide air to operate controls, valves, and other vital components for minutes after a power failure has shut down the electric system. The equation in Fig. 1 can be used to check the plant system to see how well it protects against emergencies.

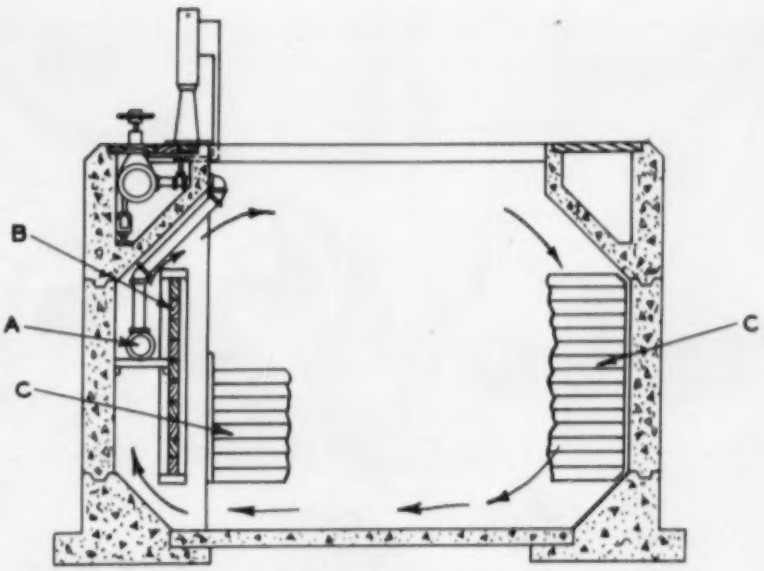


Fig. 2—AERATOR-FLOCCULATOR operated by compressed air

Flocculation

Most flocculation processes require rapid mixing at the beginning, with the mixing diminishing as the process approaches the end of the cycle. In many instances the speed of the process must be altered to suit a special treatment, a condition that is particularly well handled by compressed air.

Consider an aerator-flocculator similar to that shown in Fig. 2. It consists of a compressed air header, A, which emits a controlled air stream. The air causes the water and flocculation material to swirl in the tank, with baffles B and C directing the movement of the water to assure correct mixing. Aeration and flocculation take place simultaneously, and can be varied easily for current water conditions by either automatic or manual means. With automatic operation, the personal equation of error is reduced, if not eliminated entirely, offering a foolproof system.

Reduced Contamination

The complete absence of moving parts in this, as well as the aeration systems, is particularly attractive from the standpoint of maintenance. Furthermore, contamination of the water is practically non-existent. Aftercooling and separating devices remove entrained impurities from the air stream prior to its reaching the distribution point. Filters are available that will go further in cleansing the air by removing fine dust particles, and even undesirable odors.

Completely oil free air, through the use of carbon ring, non-lubricated compressors, will further preclude the possibility of water contamination and clogging of delicate control instruments by lubricating oil. The cast-iron piston rings are replaced by segmental carbon rings sliding on a honed cylinder bore that requires no lubricant. Piston rod packing is also made up of carbon rings (sometimes hemp), and positive protection can be had by inserting an extra long housing between the cylinder and the compressor frame, so that no part of the rod which enters the crankcase also enters the cylinder. A collar on the rod prevents oil from creeping along it into the cylinder packing box and bore.

Chemical Handling

The special construction mentioned in the preceding paragraph is sometimes necessary on compressors engaged in chemical transmission, particularly that type known as tank car unloading. Here the compressed air is piped to the top of the tank car, forcing the liquid inside to leave the car through another pipe extending to the bottom of the tank. This latter pipe is connected to the storage tank in the area of use, so that the liquid chemical is rapidly moved from place

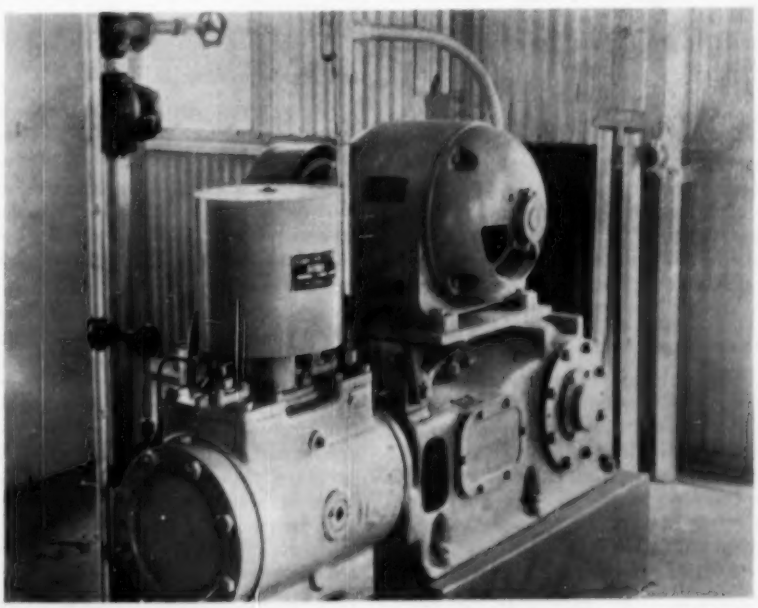


Fig. 3—NON-LUBRICATED instrument air compressor of heavy-duty type capable of delivering 1,245 cubic feet per minute at 60 psi discharge

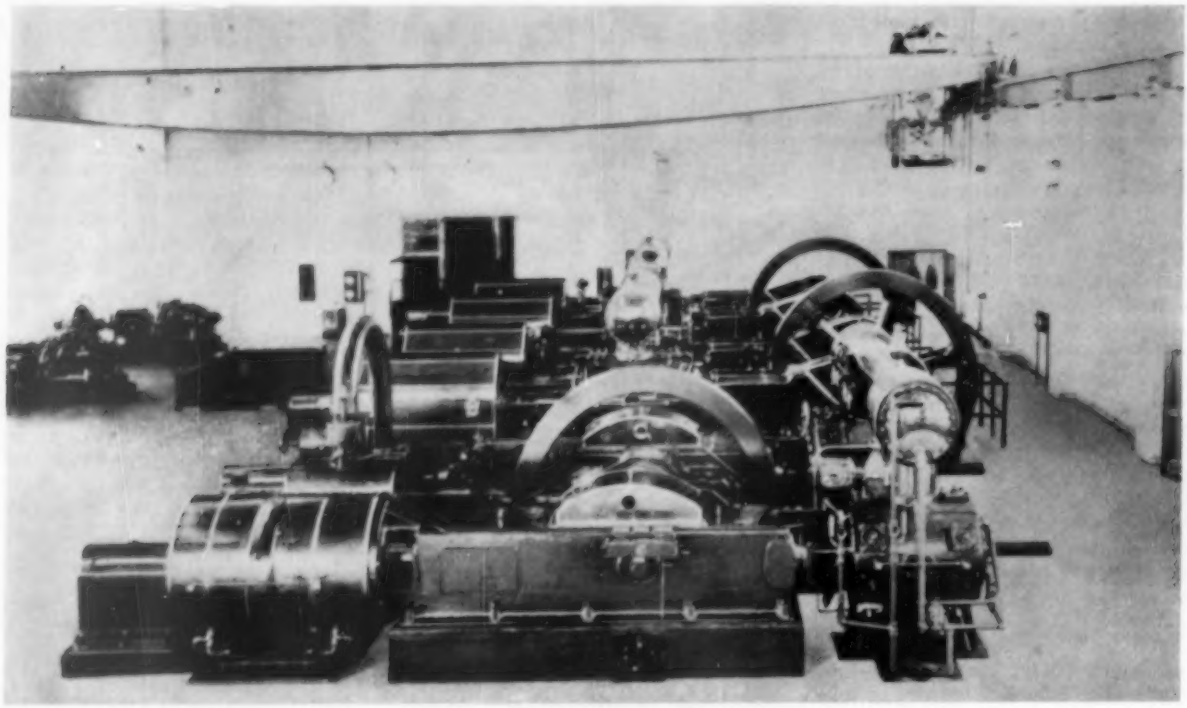


Fig. 4—STEAM-DRIVEN compressors on air lift pump service in a large southern city

to place without the use of expensive special pumps that are used only periodically.

Dry chemicals are skillfully and easily moved by canvas conveyor belts that are fluffed by compressed air.

Vacuum pumps also will handle chemicals with neatness and dispatch by creating a pressure differential between the chemical storage tank and the atmosphere. A hose attached to the tank sucks the chemical in, much in the manner of a giant-sized vacuum cleaner.

Chemical transfer by air pressure eliminates the human element that sometimes results in loose handling and slop-over, both of which are reflected in the overall cost of the chemical. Workers are also protected from the dangers of handling corrosive chemical agents, greatly enhancing plant safety practices, and compressed air never becomes tired.

Maintenance Tools

Maintenance, of course, has always been an important function of compressed air. In the use of maintenance tools, air is unequalled as a source of power. Lightweight construction, high speed operation, and freedom from electric shocks are important arguments in favor of compressed air.

Portable compressors constitute one of the greatest assets of the maintenance sections. Pavement breaking, rock drilling, and earth tamping are all facilitated by compressed air equipment at the site.

Pumping out water-filled excavations can be accomplished by portable units operating miniature air lift pumps. Maintenance of the equipment is thus kept to a minimum; large stones, gravel and broken concrete are easily handled without fear of blade or piston breakage as would be the case with centrifugal or reciprocating liquid pumps.

Miscellaneous Uses

Compressed air does not stop with those functions directly concerned with pumping or treating water.

Boiler feed control instrumentation, soot blowing, boiler tube cleaning, and ash removal all can be handled automatically with compressed air.

Carbonaceous material adhering to boiler tubes must be blown off if the steam generator is to perform at peak efficiency. Compressed air, although having a somewhat greater initial cost in some cases, permits the use of low temperature, uninsulated piping and does away with the waste of high-pressure steam. Compressed air soot blowing also has a lower operating cost than a steam cycle.

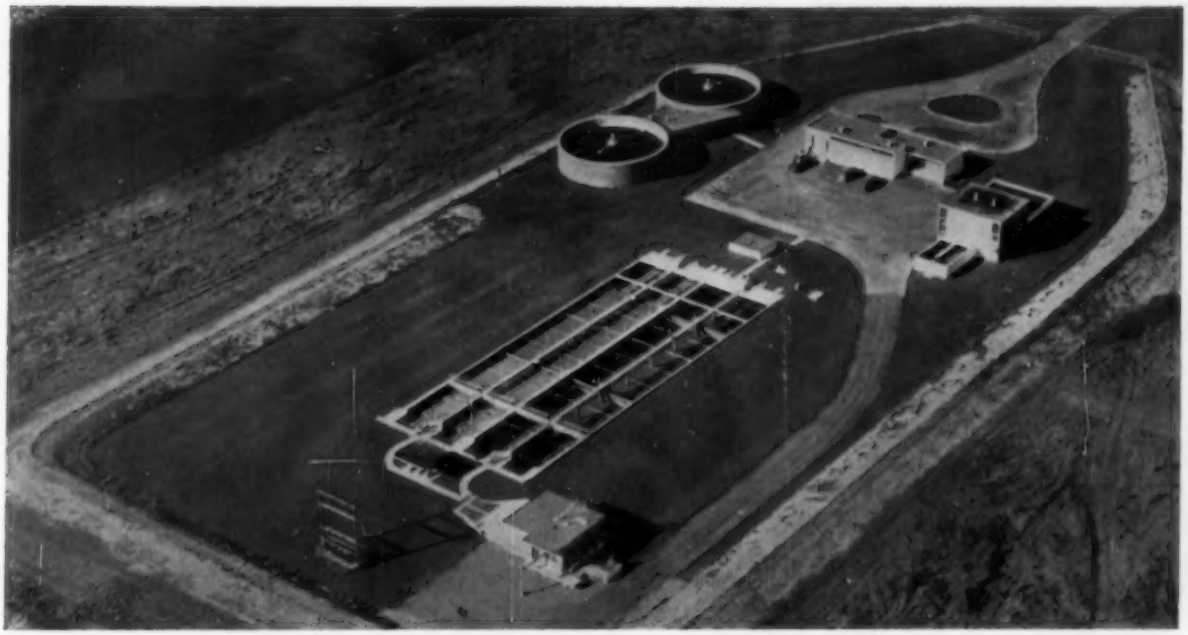
Control and instrumentation also belong among the water works components serviced by compressed air.

Exceptional sensitivity, dependability, and low cost have all contributed heavily to the use of air controlled and operated chlorinators, traveling screens, chemical mixers, boiler feed pumps, water pump discharge valves, and similar station equipment. By means of Bourdon tubes, bellows, and diaphragm needle valves, all air activated, pressure changes within a system are quickly picked up and magnified, so that sensitivity of less than one per cent is easily achieved.

A Versatile Tool

From street pavers to such simple functions as blowing the dust from a workman's bench, compressed air occupies a prominent position in the water works field. But with all its inherent ruggedness and built-in long life, the compressor must rely on the consideration of the operator and engineer to offer its maximum efficiency.

Intake filters to keep the cylinders free from abrasive dust; the proper amount and temperature of jacket cooling water (on water cooled units) to prevent overheating and moisture condensation; aftercoolers, separators, and traps to insure clean dry air being supplied to the end point; air receivers for storage purposes and pulsation damping; and a strict maintenance schedule that will assure periodic inspection of the compressor, inside and out, are all vital to the proper operation of the compressor.



SPACIOUS layout of Eugene plant provides room for expansion and addition of further treatment

Eugene Sewage Treatment Plant

by FRED MERRYFIELD and RALPH E. RODERICK

Messrs. Merryfield and Roderick are partners in the consulting engineering firm of Cornell, Howland, Hayes & Merryfield, of Corvallis, Ore. Their paper, presented at a meeting of the Pacific Northwest Sewage and Industrial Waste Assn., describes some of the notable design and construction features of this new plant.

THE CITY of Eugene, Oregon, has placed its first sewage treatment plant in operation to provide primary treatment and separate sludge digestion for a 50,000 population plus industrial loads. Adequate city-owned land is available both for expansion of the plant capacity and for additional treatment when needed. The plant is located two miles north of the present city limits in order to serve a rapidly growing and highly developed fringe area.

Interceptor and Flood Pumping Station

A new 72-inch diameter reinforced concrete interceptor connected to the original outfall at the city limits conveys the combined sewage to the treatment plant. Flows in excess of the interceptor capacity (120 cfs) are discharged over stoplog gates into the downstream section of the old outfall.

Two low lift, variable speed, vertical, mixed flow Byron Jackson Co. pumps in a pumping station at the junction of the two interceptors lift surplus flows so as to discharge through the old outfall into the Willamette River during the yearly flood periods. The sewage, normally diverted by this gate into the new interceptor, flows by gravity to the plant.

The plant provides prechlorination, coarse screening, preaeration by aerated grit removal, sedimentation, and two-stage sludge digestion. The digester supernatant is returned to the raw sewage flow, the digested sludge being dried on vacuum filters for use by the city's Park Board as lawn dressing and soil conditioner.

Raw Sewage Pumping Station

The raw sewage pumping station at the treatment plant has several features not common to the normal raw sewage pumping station.

Diversion and control features were provided at the entrance to the pumping station to control the flow to the pumps and the following treatment units. The flow is controlled by (a) recirculating plant effluent back to the pumping station to maintain a minimum flow, (b) bypassing storm flows in excess of the amount required to be treated, and (c) diverting the raw sewage to the pump selected for operation.

Since the sewage is collected by a combined system, the difference in the present minimum dry weather and the design maximum wet weather flow was about six times the low flow. It was determined that the hydraulic losses, and therefore the annual pumping costs, could be reduced considerably if the minimum flow in the plant was increased to nearer one-half the maximum wet weather flow. This increased flow permitted wider channel construction and, therefore, reduced channel depths for the maximum wet weather flows.

The present plan for plant operation provides for pumping up to three times the dry weather flow and for bypassing flows in excess of this amount directly to the river. Most of this bypassing will take place at the flood pumping station. Except for

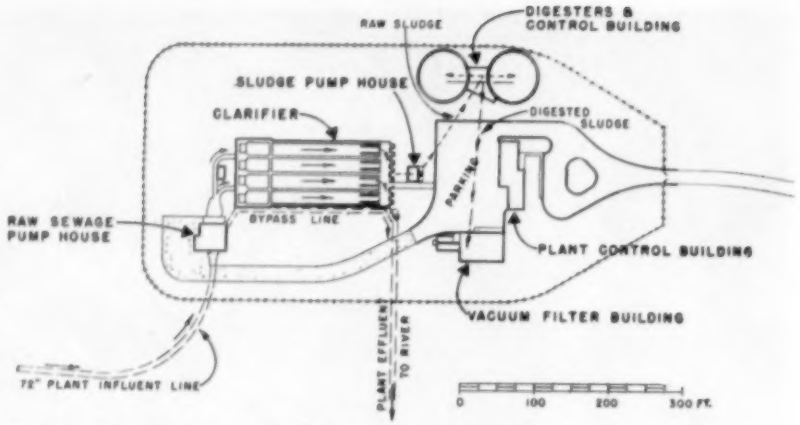
TABLE 1

Basic Design Data

Eugene, Oregon, Sewage Treatment Plant

Design population	50,000
Design flow:	
Dry Weather	250 gpdc
Minimum, present	5.0 cfs
Average, dry weather	15.5 cfs
Average, wet weather	47.5 cfs
Maximum, wet weather	47.5 cfs
Regulate to maint. min	15.5 cfs
Bar screen:	
Minimum velocity[a]	2.0 fps
Maximum velocity[a]	3.0 fps
Bar spacing	0.75 in.
Standby capacity	100%
Raw sewage pumps:	
Minimum capacity	6,750 gpm
Maximum capacity	27,400 gpm
Standby capacity	100%
Grit chamber, aerated[b]:	
Detention time[c]	6.0 min
Grit size removed	65 mesh
Preaeration:	
Detention time[c]	30 min
Air, per gallon[c]	0.1 cf
Clarifier:	
Detention time[c]	2.0 hr
Detention time[d]	50 min
Digesters:	
Capacity, dom. load	2.0 cf/cap
Capacity, indus. load	18,700 cf
Supernatant disposal	Raw Sewage
Sludge drying, vac. filters:	
Area	100 sf
Oper. time, per week	35 hr
Standby capacity	100%
Chlorination[e]:	
Capacity per 24 hr	1,000 lb

[a] In approach channel
[b] With grit removal by air lift
[c] For average dry weather flow
[d] For wet weather flow, including preaeration
[e] Prechlorination by program control



FLOW DIAGRAM indicates efficient layout

flood periods, this bypassed sewage will flow by gravity to the river. Sewage quantities in excess of three times the dry weather flow will be bypassed around the plant to the plant outfall and only the predetermined amount will be allowed to enter the raw sewage pumps.

This control is provided in the form of electrically operated sluice gates. Electric power is provided by storage batteries, thus providing for gate operation during possible power outages.

Inasmuch as each pump is capable of pumping the entire flow, only one pump is in operation at any one time and the control gates direct the flow to the pump selected.

The raw sewage pumps have mixed flow impellers installed in a wet pit axial flow pump and pump column. Although the mixed flow impeller has been used in pumps having a volute-type discharge for pumping raw sewage and flood water, no place was known where the mixed flow impeller had been used in a pump with axial flow characteristics for pumping raw sewage. A few pump companies were reluctant to recommend the use of this type of pump for pumping raw sewage, but most companies felt that they would work satisfactorily if adequate screening facilities were provided ahead of the pumps.

Because the volute-type pump required a dry pit installation, it was determined that the wet pit type pump would save approximately $35,000. Therefore, the wet pit type pump was selected.

In addition, installation of two of the wet pit type pumps with mixed flow type impellers in the flood pumping station at the upper end of the plant interceptor had already been made. It was possible to divert the raw sewage through one of these pumps and check its operation over several weeks. No apparent difficulty was encountered during this test pumping period.

Automatically cleaned bar screens in each of the two chambers remove the larger suspended matter, which is shredded and returned to the sewage downstream from the pumps. The sewage is lifted by either of the two identical, mixed flow, vertical, Peerless pumps, each of which is capable of handling the flow into the plant and is operated on alternate days.

The pumps, operating at a maximum speed of 575 rpm, discharge 27,500 gpm each under a total head of 10.2 feet through a vertical diverging column into a horizontal influent channel to the two clarifiers. Rotation of the sewage above the pump impeller is minimized by straightening vanes in the expanding pump column.

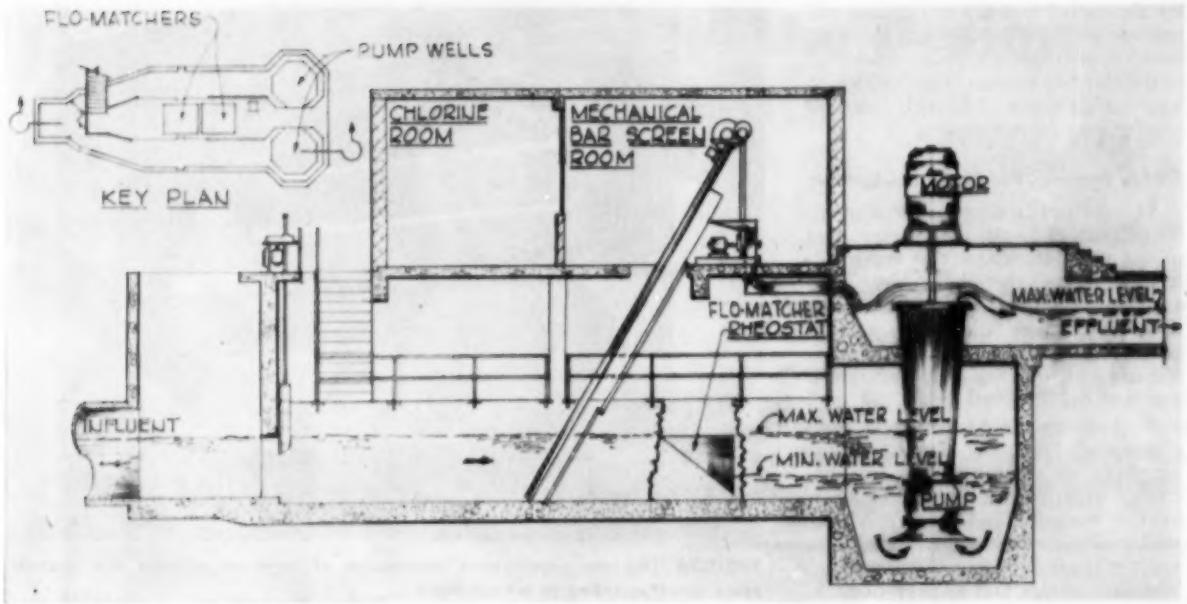
The motor speed is controlled by the use of multiple steel rheostat plates located in sumps alongside the pump influent channel. Advantage is taken of the fact that wound rotor motor terminals are accessible. External resistance is provided by the rheostats immersed in the sewage, which is an electrolyte.

The variation in this external electrical circuit is achieved by the degree of immersion of the plates in the sewage. As the level of sewage decreases the resistance in the motor circuit increases and the motor speed drops. Speed increase is produced by deeper immersion of the plates, which are designed so that the speed of motor and pump change to match the variation of sewage flow.

The plates are positioned so as to maintain a velocity of between 2 and 3 feet per second in the pump influent channel and through the bar screens. Purge water (at present fresh water, but ultimately a small portion of sewage effluent) keeps the plates clean.

The lowest discharge of these pumps at minimum operating speed is 5000 gpm. Further refinements of flow control are obtained at extremely low and high flows. During low flow a part of the clarifier effluent is returned by gravity to the influent channel to maintain a minimum flow of 12 cfs and a clean channel.

At three times the dry weather flow the electrically controlled gates, upstream from the pumps and responding to water depths in the influent channel, allow the surplus to enter the plant bypass. These gravity bypasses, both at the flood pumping station and at the plant, are more than adequate for surplus flows.



RAW SEWAGE pump house features electrically controlled sluice gates and pump motor control by rheostats immersed in sewage flow

Clarifiers, Aeration, Grit Removal And Prechlorination

The sewage is discharged from the pump columns into two rectangular curved channels followed by two longitudinal clarifiers 192 feet long, 40 feet wide and with 11-foot water depth. Each tank is divided into two bays. The first 40 feet of each tank is an aeration chamber, of which the first 8 feet is the grit removal basin.

In the first 8 feet of the aeration chamber, compressed air is delivered to diffuser tubes located 3 feet above the floor. The aeration rolls the sewage, cleans the grit and deposits it in the grit hopper. The grit is removed at intervals by airlift pumps which discharge into the plant outfall. The grit is thus carried to the river.

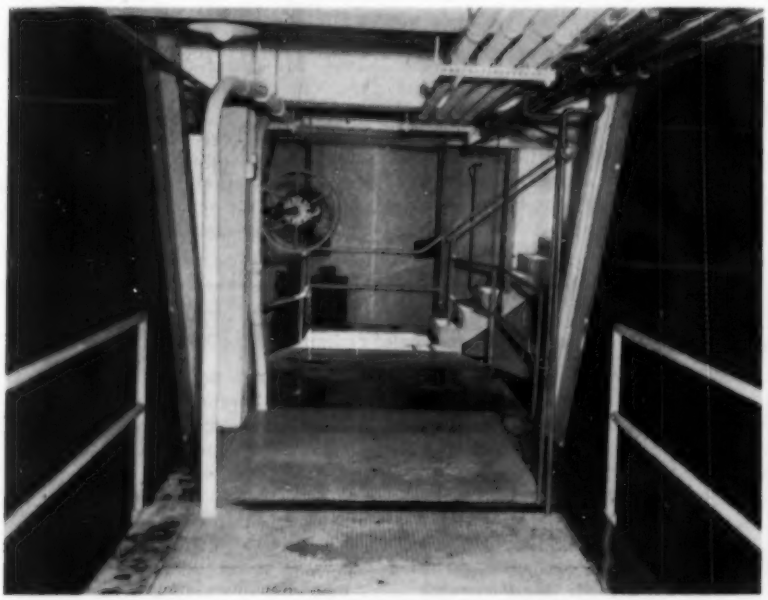
In the last 32 feet of the aeration section, compressed air is admitted through vertical nozzles set 2 feet above the floor along both walls of each bay. This air impinges on small plates and is dispersed through the sewage. By effective air control the sewage is distributed uniformly across the cross-section of the clarifier.

Preaeration was provided to freshen the stale raw sewage arriving at the plant during dry weather flows and to aid in flocculation of the suspended solids. During wet weather, preaeration is discontinued, that compartment automatically reverting to additional clarifier capacity.

The remaining 160 feet of the clarifier is devoted to scum and settleable solids removal. Two manually controlled scum channels at right angles to the flow 75 and 145 feet from the inlet end of the clarifier remove the scum, which is directed to the channels by fine water sprays. Chlorine is added during the dry weather flow just downstream from the preaeration section of the clarifier. Chlorination is primarily for influent disinfection.

The effluent is taken off the surface in the last 40 feet of the clarifier. Eight steel channels, with semi-circular bottoms, are set parallel to the flow. V-notch weirs attached to these channels control the flow. The average daily overflow rate at the dry weather flow is 780 gallons per square foot. The effluent channels discharge into a 48-inch concrete pipe, to which the bypass channel, constructed in the side of one clarifier basin, connects with this effluent pipe at a lower elevation.

A weir control at this junction made it possible to raise the invert of the outfall line 1½ feet. This seemingly small difference made it possible to



LOWER LEVEL of pump house, showing control gates (background) and rear of mechanically cleaned bar screens (sides). Motor control rheostats are in immersion pits under walkway floor plates (center)

lay the outfall in a dry trench and still provide recirculation. Structural facilities are provided for plant expansion to the clarifier system. The 1,400-foot long outfall line is of 72-inch diameter reinforced concrete pipe.

Sludge Removal, Pumping and Digestion

The sludge is scraped in the conventional manner to the downstream end of the clarifier, where two cross collectors scrape the sludge into two small hoppers. The sludge collector operates through the aeration compartment, so that when preaeration is not required this basin acts as a clarifier.

Two sludge pumps, driven at variable speed, pump the sludge into the digesters. A sight glass on the discharge pipe provides visual evidence of the quantity and quality of the sludge. Daily routine inspections have made it possible to pump a more concentrated sludge and to prevent arching of sludge in the hoppers. Through valving and fittings the scum is brought to the sludge pumps and is discharged periodically with the sludge. The pumps work at low speed and nearly continuously. They are housed in a small building at the end of the clarifiers and controlled by time clocks.

The sludge is discharged into one of the two 60-foot diameter digesters 24 feet deep, equipped with pontoon-type floating covers. The control building, for sludge digestion heating and recirculation control, is an integral part of the digester structure.

The whole structure is faced with brick, set out 2⅛ inches from the concrete. This acts as an insulator for the digester.

Sludge pumps, suitable piping, and lubricated plug-type valves provide for recirculation of the sludge, for transfer from one to the other digester, and for transfer of the digested sludge to the sludge treatment building.

The digesters can be operated in series or parallel; both tanks are equipped for primary or secondary digestion. The incoming sludge is heated in an external heat exchanger. Hot water heated in a gas- or oil-fired boiler provides heat for this exchanger.

Sludge Disposal

The Willamette Valley, in which Eugene is located, is well known for its rainfall. The annual rainfall in the main valley is approximately 38 inches, this rain being distributed from September to May. Because of the drying problems presented, vacuum filtration of conditioned digested sludge is provided for in a separate building.

RHEOSTAT for one pump shows construction of immersed element that controls pump speed according to sewage depth

It is possible to elutriate the sludge from the primary digester and to return it to the secondary when they are operated in series, thus reducing the moisture content of the sludge entering the secondary digester and the solids content of the supernatant liquor. Elutriation also can be used to reduce the alkalinity of the digested sludge prior to drying on the vacuum filters. Piping arrangements are such that both operations can be accomplished with the same unit.

Underwater Concrete Construction

An item of construction which may be of particular interest was a method used in pouring concrete below the ground water table. Although pumps were able to hold the water down to a few inches in depth, the flow of water to the pumps would wash the cement out of the concrete before it would be able to cure.

By placing an old tarpaulin in the pit and pouring the concrete onto the tarpaulin, water was able to flow under the tarpaulin until the weight of concrete above the tarpaulin cut off this flow. The tarpaulin would yield under the weight of the concrete and permit the concrete to conform to the shape of the supporting surfaces, thus providing a watertight form.

Personnel

The plant was supervised by Mr. Ralph Roderick, partner of the firm of Cornell, Howland, Hayes & Merryfield. Mr. Ed Greey was the firm's resident engineer. Mr. Oren King (later Mr. R. A. Finlayson), City Manager of Eugene, and Mr. William Clubb, City Engineer, represented the city. Mr. William Newell, superintendent of the sewer department, was active in construction inspection.

Contractors and Major Equipment Suppliers

Primary contractor	Lee Hoffman, Eugene, Ore.
Mechanical sub-contractor	Joe Swearingen, Jasper, Ore.
Electrical sub-contractor	L. H. Morris, Eugene, Ore.
Flood lift station pumps	Byron Jackson Company
Bar screens, mechanically cleaned	Link-Belt Company
Raw sewage pumps	Peerless Pump Division
Sludge collectors	Link-Belt Company
Sludge heat exchanger	Pacific Flush Tank Co.
Floating digester covers	Pacific Flush Tank Co.
Vacuum sludge filters	Eimco Corporation

A Rational Approach to the Design of Activated Sludge Plants

by T. R. HASELTINE

Mr. Haseltine, a partner in The Chester Engineers, Pittsburgh, Pa., has long been interested in the factors affecting economy of design and efficient operation of activated sludge plants. His paper was presented at the Manhattan College Conference on Biological Waste Treatment.

ALTHOUGH additions to knowledge of the activated sludge process appear in the technical press almost monthly, there has been little, if any, advancement in design criteria during the past thirty years. A national survey[1] of State Health Department requirements made in 1948 showed that only nine states had any specific requirements concerning activated sludge plant design. For diffused air plants, those states specified an aeration period of 4 to 8 hours and an air supply of 0.5 to 2.0 cubic feet per gallon of sewage. Aeration periods were based on sewage flow plus return sludge, which was usually specified to be 25 percent of the sewage flow.

The designs of the earlier activated sludge plants were based largely on the results of protracted and exhaustive pilot plant operations. Unfortunately, the designers of many of the more recent plants have had little or no experience in the actual operation of the process. The fact that many such plants have proved highly successful is due more to the ingenuity of the operators and the helpfulness of design criteria privately developed by equipment manufacturers, than to the skill of the designer or the adequacy of State Health Department regulations.

The newer "Ten State Standards for Sewage Works"[2] consider the B.O.D., as well as the volume of the sewage or waste to be treated, and so are superior to the earlier criteria. However, neither they, nor any of the design standards developed by equipment manufacturers, make any mention of the amount of activated sludge to be carried.

Because activated sludge is essential to the process, and because the amount of sludge carried has a marked influence on the functioning of the process, it would appear essential for the designer to select the optimum, or maximum, sludge load and then design the plant to carry that load. The failure to properly evaluate this important factor may well explain the prevalence of sludge bulking and the frequently repeated statement that "the process requires expert operating attention and is easily upset by industrial wastes."

Sludge reæration is another phase of design which is totally ignored by practically all design criteria. Many of the early plants included sludge reæration, but most of those constructed during the 1930's omitted such provisions. Nevertheless, Hatfield at Decatur and Kraus at Peoria[5] have been making old plants operate at far above their original design loads for decades by sacrificing mixed liquor æration in order to gain the separate sludge reæration not provided in the original designs. Since World War II sludge reæration, in various forms, has gained in popularity. Certainly any modern design criteria should evaluate sludge reæration as well as total sludge load.

This paper presents an approach to the design of an activated sludge plant which is believed to be more rational than that afforded by any presently accepted criteria. Although the suggested procedures are applicable to sewage or wastes of unusual strengths, they are not intended to be a substitute for actual pilot plant investigations wherever such investigations are feasible. Like most other design criteria, they must be tempered with the judgement of one familiar with the design, construction and operation of the process. No criteria can be set up that will insure the sucecss of an inexperienced designer.

This paper is not based on any original laboratory or plant-scale experiment. Instead, it is based entirely on a re-evaluation of the published work and findings of others. The author gratefully acknowledges the value of the original investigations.

Optimum Quantity of Sludge

When an adequate quantity of well-activated sludge is mixed with sewage or waste, the waste is clarified; that is, most of its pollutants and many bacteria and protozoa are adsorbed by the sludge. In the presence of an adequate supply of oxygen, some biological forms die off or remain dormant while others multiply rapidly. By their growth these organisms convert pollutants to carbon dioxide, sulfates, nitrates and the living protoplasm of their bodies. During the progress of this biological oxidation, enzymes may be secreted which hasten and improve clarification.

Both oxidation and clarification take place most rapidly when activated sludge and sewage are first brought together, providing there is sufficient oxygen available. Clarification or adsorption will be substantially complete in 20 to 40 minutes, but several days may be required for complete oxidation.

A balance must be maintained between the two. If oxidation lags behind adsorption, the settleability of the sludge deteriorates and "bulking" is encountered, although clarification may still be excellent. If oxidation lags still farther behind, the sludge will lose much of its clarifying power, although its settleability may improve and become even better than that of fully activated sludge. Such a sludge can still produce considerable purification, even though it cannot yield the clear, sparkling effluent typical of the conventional activated sludge process.

TABLE 1

Conventional Activated Sludge
(No Separate Sludge Reaeration)

Plant		Period	Sewage to Aerators			Mixed Liquor	
No.	Location		Flow, mgd	Susp. Sol., ppm	5-Day B.O.D., ppm	Susp. Sol., ppm	Sludge Age*, days
1	Ann Arbor, Mich.	1944-46	5.0	128	182	1844	4.2
2	Ann Arbor, Mich.	1947	6.7	107	169	1850	3.87
3	Baltimore, Md.	1945	10.64	92	217	937	4.74
4	Chicago S.W.	1946	288.0	.....	129	1930	.....
5	Chicago S.W.	1951-52	794.0	105	97	2330	4.2
6	Chicago N.S.	1946	197.5	.....	97	2400	.....
7	Chicago N.S.	1946-50	213.0	88	77	2000	5.7
8	Chicago Calumet	1946	71.8	.....	94	2190	.....
9	Chicago Calumet	1946-50	77.0	105	87	2230	5.4
10	Cleveland East	1940-45	86.9	146	91.5	2180	4.89
11	Ft. Wayne, Ind.	1941-45	14.92	151	161	2420	6.77
12	Gary, Ind.	1941-45	19.0	101	77	1325	3.25
13	Hagerstown, Md.	1943-46	3.87	286	254	1808	2.37
14	Hammond, Ind.	1942-46	20.2	152	135	2196	5.90
15	Indianapolis, Ind.	1942	17.83	215	182	2400	4.87
16	Indianapolis, Ind.	1943	7.98	224	181	2600	6.47
17	Indianapolis, Ind.	1944	11.34	234	193	2800	8.15
18	Jackson, Mich.	1942-46	8.04	144	118	2801	5.41
19	Madison, Wis.	1947	7.60	.....	157	1094	.....
20	Marion, Ind.	1942-45	3.92	117	134	2625	5.30
21	Marshalltown, Iowa	1943-46	3.35	130	177	2500	7.45
22	Milwaukee West	1945	65.4	315	332	3000	4.20
23	Milwaukee East	1945	56.0	315	332	3000	3.46
24	Omaha, Neb.	1946	2.54	149	128	1720	5.84
25	Pontiac, Mich.	1946	4.8	73	125	1200	3.94
26	Richmond, Ind.	1942-46	5.45	92	113	1680	6.20
27	Springfield, Ill.	1942	9.2	81	74	1580	5.78
28	Springfield, Ill.	1937-41	7.8	120	132	1863	4.86
29	Syracuse, N. Y.	1947	4.31	.....	236	2218	.....
30	Two Rivers, Wis.	1946	0.98	86	114	1500	9.16

* Gould sludge age (See Ref. 3)

It is these flocculated, or partially activated, sludges that are typical of most of the newer "modified æration" or "high-rate activated sludge" processes.

On the other hand, if oxidation materially exceeds adsorption much of the sludge will be destroyed by wet combustion; the remaining floc particles become very small and compact. Such a sludge does not produce a sparkling clear effluent, although nitrification may be high. Apparently some of the sludge is broken up into "pin point floc." These particles do not settle in final clarifiers, even though the main body of the sludge has a low Mohlman index. A nitrifying sludge does not bulk. However, liberation of gaseous nitrogen may cause chunks of sludge to rise to the surface of final tanks.[7]

There is a close relationship between the oxidation-adsorption balance and the amount of sludge carried in an æration tank. The less the amount of sludge carried in proportion to the daily pollutional load, the higher will be the adsorption of pollutants per unit weight of sludge. Either more time for oxidation, or a higher rate of oxidation, must be maintained if bulking is to be avoided in the conventional process. Although bulking would not occur in the modified æration processes, a further drop in clarification and degree of treatment would result.

The operator can measure the quantity of sludge in his æration tank by simply determining the mixed liquor solids concentration. However, this is true only because the volume of his tank is fixed.

The designer, on the other hand, has an infinite choice of æration tank volumes. Therefore, he must consider that volume as well as the concentration of solids if he is to have a true measure of sludge quantity.

The "Gould sludge age"[3, 8, 9] is the ratio of total weight of suspended solids in the mixed liquor to the weight of suspended sewage solids introduced into the ærators daily. It should be noted that this definition assumes that there are no significant accumulations of sludge in the final settlers. Edwards[8] and Gould[3, 9] state that for the conventional process a sludge age of at least 3 days is necessary and 4 days is desirable; for the high-rate process the age should range from 0.4 days in cold weather to 0.2 days in hot. Between the conventional and modified processes there is an intermediate zone (that is, sludge age 0.5 to 3.0 days) where a high Mohlman index and a poorly settling sludge is encountered.

This concept of sludge age implies that the suspended solids in the mixed liquor are simply an accumulation of suspended solids removed from the incoming sewage. Actually, the mixed liquor solids in a conventional plant are primarily zoogleal masses of bacteria, together with large numbers of protozoa and other microscopic organisms.

Although the sludge age concept has proved useful in the New York City plants, its application to plants treating wastes having a different

TABLE 1 (Continued)

Plant No.	B.O.D Applied, lb per day: Per 100 lb Mixed Liq. Sol.	B.O.D Applied, lb per day: Per 1000 cf Aeration Tank Vol.	Air Used, cu ft: Per Gallon	Air Used, cu ft: Per lb B.O.D. Remov.	Return Sludge, percent by Vol.	Aeration Period, hr: Sewage Only	Aeration Period, hr: Mixed Liquor	Removal, Percent: Susp. Sol.	Removal, Percent: 5-Day B.O.D.	Reference
1	34.0	39.0	1.05	770	32.0	6.99	5.3	90.7	89.6	6
2	41.1	47.1	0.92	703	30.8	5.36	4.1	89.0	92.3	6
3	49.9	28.8	1.24	728	21.5	11.25	9.27	91.3	93.6	6
4	17.7	21.0	0.86	876	47.9	8.7	5.9	.....	91.5	6
5	21.8	32.0	0.68	905	38.5	4.6	3.3	86.0	92.0	13
6	14.8	22.1	0.49	645	24.0	6.56	5.3	.....	93.8	6
7	15.4	19.0	0.48	800	22.7	6.0	4.9	88.5	92.5	13
8	15.7	21.6	0.48	677	25.9	6.53	5.2	.....	90.4	6
9	15.4	19.0	0.48	740	24.4	6.1	4.9	87.0	87.5	13
10	12.5	17.4	1.06	1600	24.9	7.73	6.2	90.8	86.9	6
11	15.8	23.7	0.95	773	30.5	10.0	7.7	89.1	91.0	6
12	23.5	19.4	0.47	796	33.2	5.85	4.4	92.9	89.6	6
13	39.0	44.1	0.92	500	31.5	8.8	6.7	95.5	86.8	6
14	14.4	19.9	0.66	655	51.9	10.9	7.2	88.8	91.5	6
15	17.3	26.1	1.45	847	27.2	10.5	8.28	96.7	95.0	21
16	12.5	27.0	1.68	1060	70.0	13.45	7.9	94.2	92.2	21
17	10.1	16.5	1.52	1095	83.3	16.35	8.9	97.9	94.8	21
18	14.9	26.4	0.65	690	15.5	6.7	5.8	88.5	94.9	6
19	38.8	26.4	1.23	690	51.6	9.1	6.0	.....	77.1	6
20	21.6	35.4	0.89	886	30.8	5.7	4.34	89.8	89.7	6
21	18.3	28.6	1.45	1245	31.3	9.22	7.03	62.3	79.2	6
22	25.2	47.0	1.90	725	24.9	10.55	8.45	93.6	94.6	6
23	30.3	52.0	1.26	481	21.5	9.57	7.88	95.2	94.8	6
24	14.7	15.8	1.04	1210	60.4	12.2	7.6	79.9	80.5	6
25	43.5	32.5	0.83	886	20.8	5.75	4.77	86.3	90.0	6
26	19.8	20.6	0.39	435	28.5	8.22	6.4	82.6	94.7	6
27	15.9	15.6	0.64	1120	38.1	7.6	5.5	90.2	89.3	6
28	22.6	23.5	0.70	710	27.6	8.45	6.6	90.9	90.2	6
29	34.6	47.8	1.23	1410	26.2	7.57	6.0	.....	86.4	6
30	14.6	13.7	.....	.....	48.0	12.5	8.44	80.3	90.9	6

ratio of B.O.D. to suspended solids is questionable. Heukelekian, Orford Manganelli[10] found that the rate of activated sludge accumulation was primarily a function of the B.O.D. input to the process. This indicates that the total quantity of the sludge carried in a plant should be correlated with the daily B.O.D. load imposed on the process. Although such a parameter has not been widely used, the National Research Council[11] found a relationship to exist between the Mohlman index and the average weight of B.O.D. entering the aerators per day per pound of suspended solids in them and the final clarifiers. Okun[12], in his bio-precipitation studies, found the efficiency of B.O.D. removal to be related directly to weight of total, or volatile, solids in the unit and inversely to the organic loading.

Table 1 summarizes published operating data on numerous conventional activated sludge plants. Table 2 contains similar data for several modified plain aeration plants.

Fig. 1 has been prepared from those data to show the relationship between B.O.D. loadings and removals per 100 pounds of mixed liquor suspended solids. Curve A shows the data for conventional plants; Curve B is plotted from all data.

The curves indicate that the activated sludge process alone, exclusive of primary treatment, can be expected to yield about 90 percent B.O.D. reduction as long as the daily 5-day B.O.D. load does not exceed about 50 pounds per 100 pounds of suspended solids in the aeration tanks. If higher loads are applied, lower percentage reductions result. At a load of 400 pounds, the reduction is only about 54 percent.

The change in slope of the curve occurs at loadings between 50 and 100 pounds. This probably represents the middle ground between the conventional and high-rate processes where severe bulking is likely to be encountered.

Thus, as far as the conventional process is concerned, it appears that the maximum B.O.D. load should not exceed 50 pounds per day per 100 pounds of mixed liquor solids. Even at design, the average load should be somewhat less. It is suggested that moderate to large plants be designed for an average of 30 to 40 pounds. Extremely small plants that will not receive 24-hour attendance or skilled operation, might be designed for loadings of only 20 to 30 pounds of B.O.D. per 100 pounds of sludge solids, even though such a practice will increase their power requirements.

Although that portion of Curve B which applies to loadings in excess of 100 pounds of B.O.D. per 100 pounds of solids is based on relatively few rather scattered points, it may be helpful in selecting the weight of mixed liquor solids required to obtain any predetermined degree of B.O.D. reduction from modified aeration processes. In making that selection, care should be taken to avoid minimum loadings of 100 pounds or less of B.O.D. per 100 pounds of solids, in

order to minimize the chance of bulking, even though the curve indicates that B.O.D. reduction would be greater at that loading than at higher loadings.

Until more is known about modified æration processes, it might be well for the designer to consider a combination of primary and conventional activated sludge treatment to yield the same over-all B.O.D. reduction as that to be expected from modified æration. By so doing, he would avoid the pitfalls inherent in designing for any new and poorly understood processes.

In any event, the previously described procedure offers a method for selecting the sludge load for which the plant is to be designed. Thus, if it is required to treat 24 mgd of settled sewage having a B.O.D. of 200 ppm by the conventional activated sludge process, the B.O.D. input to the æration tanks will be 24 x 8.34 x 200, or 40,000 pounds per day. If the B.O.D. loading is limited to 35 pounds per day per 100 pounds of sludge solids, a total of 40,000 x 100/35, or about 114,300 pounds of sludge solids are required. They might all be carried in æration tanks, or a portion of them might be carried in a separate sludge reæration tank. The volume of the tanks required would depend on the concentration of solids in them.

Without separate sludge reæration, a 5-mg æration tank with a mixed liquor solids concentration of 2,740 ppm, or a 10-mg æration tank with a solids concentration of 1,370 ppm might be used.

If a solids concentration of 4,800 ppm was carried in a 2-mg separate sludge reæration tank, then an æration tank of only 2-mg capacity with a mixed liquor solids concentration of 2,050 ppm would suffice.

In all three cases, the true sludge age would be the same. Therefore, assuming a continuous and adequate oxygen supply, the same average oxidation-adsorption balance, and hence the same sludge condition, would be maintained.

However, the combined æration and reæration tank volume per pound of B.O.D. applied would be vastly different.

In the three foregoing examples the combined æration volume per pound of applied B.O.D. would be 16.7, 33.4 and 13.4 cubic feet, respectively (Fig. 2). This illustrates the fallacy of setting up a volumetric B.O.D. loading criteria for æration tanks without giving consideration to their sludge content, as is done in the "Ten State Standards"[2] or many of the equipment manufacturers' design criteria.

Such a volumetric requirement may be likened to trickling filter design practice where B.O.D. loadings are related to volume of filter stone. It is not the stone, but the biological growth on the stone, that accomplishes the purification. However, since neither the designer nor the operator can measure the amount of such growth, we have been content with a correlation between B.O.D. load and stone volume.

Such is not the case in the activated sludge process. There the amount of growth can be readily measured and controlled. Therefore, it should be a governing factor in plant design.

Return Sludge Capacity

No doubt there are limiting maximum concentrations of solids that may be carried in either æration or sludge reæration tanks. However, it will be shown that if the rate of sludge return is adequate to prevent undue accumulations of sludge in final settlers during periods of high Mohlman index, the solids concentrations in either æration or reæration tanks will not be excessive.

An average Mohlman index of about 100 is generally considered very satisfactory at conventional activated sludge plants of the diffused air type. However, Pearse and his committee[14] show that even at plants where the average index is about 100, the daily index may range from a minimum of 30 to a maximum of 300 to 400.

The maintenance of a constant B.O.D. to solids loading would probably reduce much of that variation, but in view of the highly variable B.O.D. input to most plants, such an ideal situation is impossible of attainment. Therefore, the designer should provide for satisfactory operation at a Mohlman index considerably above

TABLE 2

Plain Aeration and High-Rate Activated Sludge

Plant		Period	Sewage to Aerators			Mixed Liquor	
No.	Location		Flow, mgd	Susp. Sol., ppm	5-Day B.O.D., ppm	Susp. Sol., ppm	Sludge Age*, days
50	Ann Arbor, Mich.	1945-46	5.3	103	171	150	0.40
51	Indianapolis, Ind.	1942	42.23	215	182	.....	0.27*
52	Indianapolis, Ind.	1943	53.36	224	181	.....	0.33*
53	Indianapolis, Ind.	1944	51.92	234	193	.....	0.31*
54	Philadelphia N.E.	Jan.-Mar. 1954	79.8	132	132	522	0.80
55	Philadelphia N.E.	Oct.-Dec. 1953	82.3	106	130	399	0.73
56	NYC Owls Head	July 1952-53	85	160	170	360	0.23
57	NYC Jamaica	1952	51	168	109	850	0.40
58	NYC Rockaway	July-Aug. 1953	18	119	105	990	0.59
59	Syracuse, N. Y.	Nov. 1944-April 1945	4.59	83	78	.....	0.34*
60	NYC Jamaica	Oct.-Dec. 1943	33.7	211	152	384	0.43
61	NYC Jamaica	Dec. 1943-Feb. 1944	29.5	283	155	626	0.31
62	NYC Jamaica	Mar.-May 1944	32.0	193	136	580	0.79
63	NYC Jamaica	June-Aug. 1944	33.0	206	111	634	0.38
64	NYC Jamaica	Aug.-Sept. 1944	37.3	202	105	365	0.20
65	Bowery Bay	1944	37.8	113	103	505	0.60

* Gould sludge age (See Ref. 3)

* Based on assumption that the average suspended solids in aerator is same as that in entering sewage.

100. It is suggested that moderate to large plants be designed for an index of 250 and small plants, where continuous skilled operation is improbable, be designed for an index of 350.

Undue retention of sludge in final settlers retards biological oxidation. In 1940, Bloodgood[15] stated:

"There is one rule that we have established for activated sludge plant operation: the return sludge concentration must never be allowed to exceed the sludge index (expressed as percent solids). This has proved an excellent guide, as following this rule does not permit the retention of sludge in settling tanks long enough to become damaged."

The sludge index expressed as percent solids is the Donaldson index, or $\frac{100}{\text{Mohlman index}}$. Thus, by Bloodgood's rule, the concentration of return sludge would be 4,000 ppm for a Mohlman index of 250, and 2,860 ppm for an index of 350. However, in 1944 Bloodgood[16] stated that return sludge concentrations might be 1.1 times the concentrations as above computed.

In 1949 Kraus[17] stated that this factor, K, might be as high as 1.2, at least for Mohlman indexes of less than 100. If the 1.2 value of K is assumed to apply to a Mohlman index of 250, the concentration of solids in the return, and hence that in the sludge reæration tank, designed as herein suggested, should be 4,800 ppm.

Bloodgood[16] also presented a nomograph to illustrate the relationship between Mohlman index, return sludge solids concentration, mixed liquor solids concentration and return sludge percentage for a K value of 1.0. Fig. 3 is similar to Bloodgood's nomograph, except it covers a wider range of values and permits readings to be made for any K value from 1.0 to 1.2. It shows that for a Mohlman index of 250 and a K value of 1.2, a return sludge capacity of 135 percent would be required if a mixed liquor solids concentration of 2,740 ppm was carried.

If the mixed liquor solids were halved to 1,370 ppm, a return sludge capacity of only about 40 percent would be needed. A mixed liquor solids concentration of 2,050 ppm would require about 75 percent return sludge capacity.

It seems doubtful that designers will find it economical to provide a return sludge capacity in excess of 100 percent. Based on a K value of 1.2, this would limit the mixed liquor solids concentration to 2,400 ppm for a Mohlman index of 250, or to 1,720 ppm for an index of 350.

Aeration Period

If the foregoing procedure is followed, the total volume of æration and sludge reæration tanks are set by (a) the B.O.D. to solids loading, (b) the maximum sludge index, and (c) the capacity of the return sludge facilities.

Both the sewage and the mixed liquor æration periods are ignored. Since most of the pollutants are quickly adsorbed by the sludge, neither of these periods is of any real significance. However, since 20 to 40 minutes may be required for completion of adsorption, and since there may be some short-circuiting in the æration tank[18], it is probably desirable to provide a mixed liquor æration period of at least 60 to 90 minutes. This offers a logical method for dividing the total æration tank volume between mixed liquor æration and sludge reæration.

In the foregoing example a 2-mg æration tank and a 75 percent return sludge capacity was indicated for a 24-mgd sewage flow if a 2-mg sludge reæration tank was also provided. Under these conditions, the theoretical mixed liquor æration period would have been $(2 \times 24)/(24 \times 1.8)$, or 1.14 hours.

The design procedures herein proposed may result in the use of considerably higher rates of sludge return than are generally provided. Therefore, it may be pertinent to point out that the average sewage æration period is independent of the amount of return sludge. For example, with 100 percent return sludge the mixed liquor æration period will be just one-half of what the sewage æration period would have been with

TABLE 2 (Continued)

Plant No.	B.O.D Applied, lb per day: Per 100 lb Mixed Liq. Sol.	B.O.D Applied, lb per day: Per 1000 cf Aeration Tank Vol.	Air Used, cu ft: Per Gallon	Air Used, cu ft: Per lb B.O.D. Remov.	Return Sludge, percent by Vol.	Aeration Period, hr: Sewage Only	Aeration Period, hr: Mixed Liquor	Removal, Percent: Susp. Sol.	Removal, Percent: 5-Day B.O.D.	Reference
50	415	39.6	0.5	594	0.0	6.6	6.6	66.0	63.1	6
51	314*	40.6	0.49	544	0.0	6.43	6.43	74.4	43.5	21
52	246*	34.2	0.53	623	0.0	7.9	7.9	75.4	49.1	21
53	271*	41.0	0.59	577	0.0	7.45	7.45	80.2	45.1	21
54	126	41.0	0.68	1060	24.0	4.81	3.88	52.3	58.4	24
55	167	41.6	0.47	975	36.3	4.67	3.42	43.4	44.6	24
56	465	105.0	0.49	595	10.6	2.45	2.3	73	58	3
57	162	87.0	0.33	477	18.0	1.9	1.6	83	76	3
58	149	92.0	0.34	606	7.0	1.7	1.6	66	64	3
59	276*	14.3	0.59	1436	0.0	8.2	8.2	62.6	71.8	22
60	167	39.5	0.45	450	17.8	5.69	4.88	85.5	76.8	23
61	177	69.3	0.43	453	30.5	3.34	2.56	86.8	71.1	23
62	91	33.0	0.41	473	28.1	6.16	4.82	84.5	76.5	23
63	141	55.7	0.40	608	27.3	2.99	2.35	81.8	71.0	23
64	264	60.2	0.38	615	16.0	2.64	2.28	85.2	69.8	23
65	168	52.8	0.39	590	28.5	3.21	2.5	74.4	76.7	25

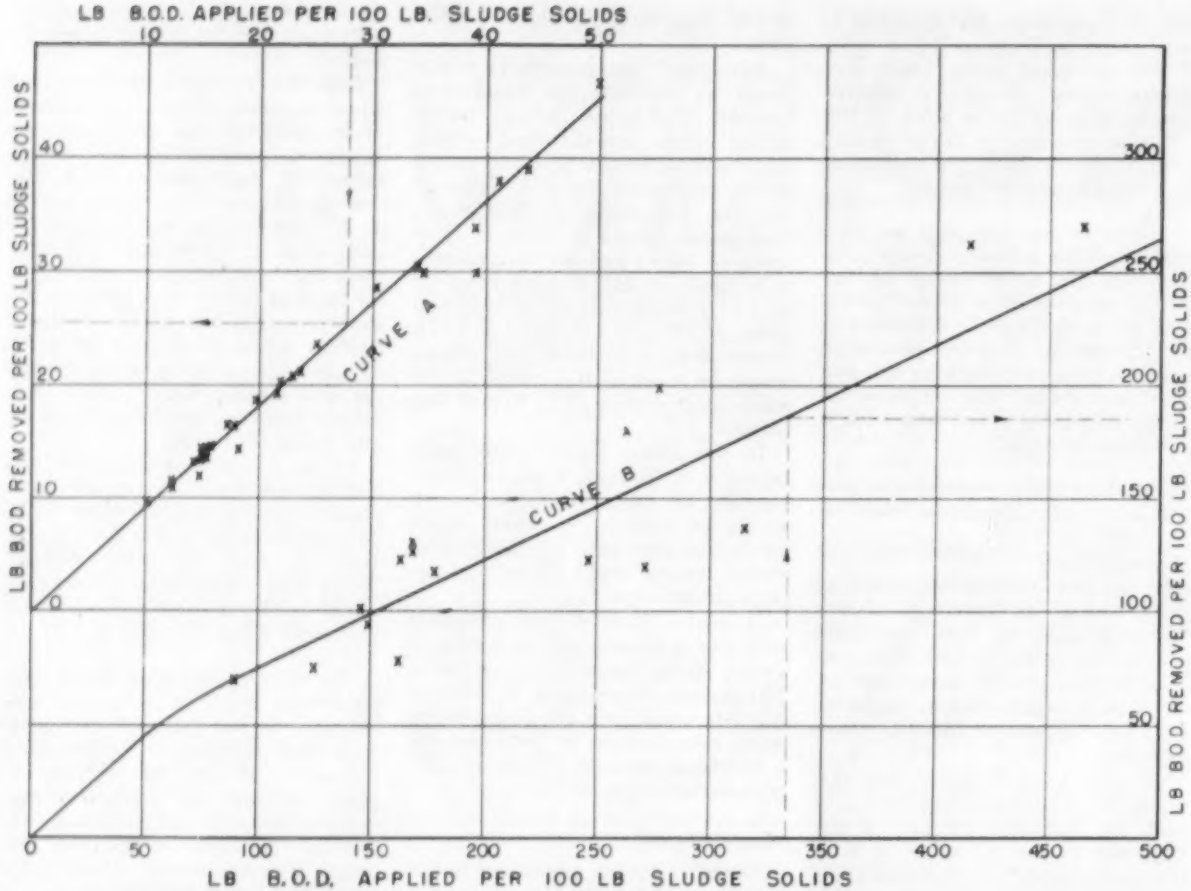


Fig. 1—RELATIONSHIP between B.O.D. loading and B.O.D. removal (see text for explanation)

no return at all. However, on the average, all of the sewage would pass through the æration tank twice, instead of once, so the effective sewage æration period is unchanged.

As long as the mixed liquor æration period is long enough to permit substantially complete clarification, any further oxidation of soluble material can be accomplished just as well on the second pass through the ærator as on the first. It is generally accepted that recirculation (at least up to a ratio of 1 or 2) greatly improves the removal of B.O.D. by trickling filters. There is no reason why it should not have a similar effect in the activated sludge process.

The National Research Council[11], Fair and Thomas[4], Smith[20] and others have proposed loading parameters that were equivalent to the B.O.D. to solids loading proposed in this paper, divided by the æration period. Fair and Thomas used the sewage æration period; Smith used the mixed liquor æration period.

Both of these conceptions are erroneous because they fail to consider the fact that the sludge solids are retained

Given:

Sewage flow, 24 mgd
B.O.D. of settled sewage, 200 ppm
B.O.D. loading, 35 lb per day per 100 lb of sludge solids

Calculations:

Applied B.O.D. = 24 x 8.34 x 200 = 40,000 lb per day
Sludge solids required = 40,000 x 100/35 = 114,300 lb

Possible designs:

Example number	1	2	3
(a) Sludge reaeration tank vol., mg	0	0	2
(b) Mixed liquor aeration tank vol., mg	5	10	2
(c) Sludge reaeration solids conc., ppm	....	....	4,800
(d) Mixed liquor solids conc., ppm	2,740	1,370	2,050
(e) Total reaeration sludge solids, lb (a x c x 8.34)	0	0	80,100
(f) Total mixed liquor sludge solids, lb (b x d x 8.34)	114,300	114,300	34,200
(g) Total sludge solids, lb (e + f)	114,300	114,300	114,300
(h) Combined aeration volume, cu ft per lb of B.O.D. 1,000,000 (at b)/40,000 x 7.49)	16.7	33.4	13.4

Fig. 2—ILLUSTRATIVE examples of how logical design affects aeration volume

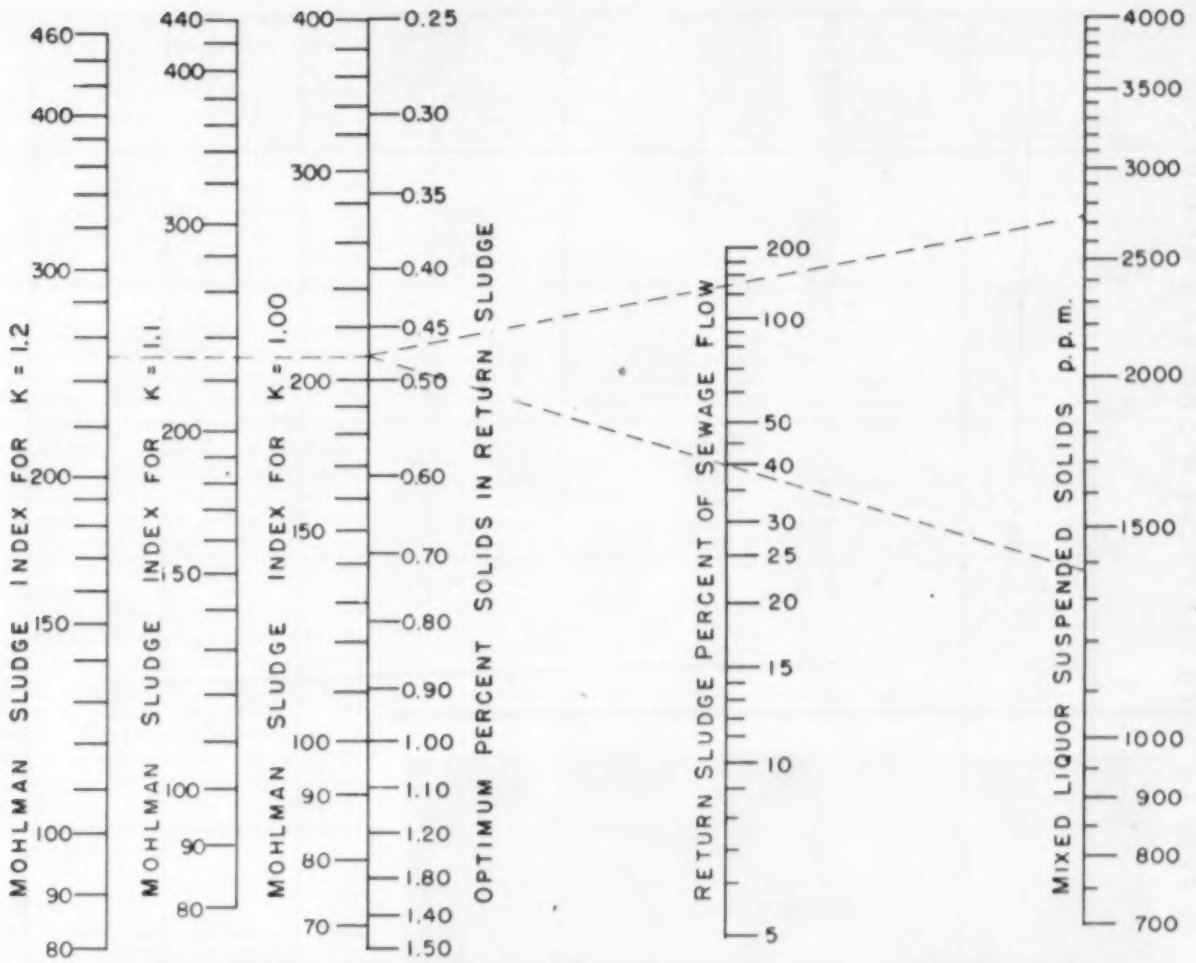


Fig. 3—NOMOGRAPH for determining optimum solids content and percent of return sludge from Mohlman index and mixed liquor solids concentration

in the plant through several cycles of even days. During all of that time they are undergoing oxidation. The important thing is to retain the solids in the æration system long enough to permit oxidation to balance adsorption. The sludge retention period is governed primarily by the B.O.D. to solids loading, and is independent of either the sewage or mixed liquor æration period.

Obviously, high return sludge rates increase the mixed liquor flow. However, this should not necessitate the use of larger final settlers if they are so arranged that sludge is withdrawn from a point directly below the tank inlet. However, if the point of sludge withdrawal is remote from the inlet, as in Gould's design[19], the procedure recommended herein will necessitate the use of larger final sedimentation units.

Sludge Reaeration

In the foregoing procedure the concentration of solids in the sludge reæration tank, and hence its volume, is primarily dependent upon the maximum Mohlman index selected for design. Obviously, the normal index will be lower and so the operator could frequently operate with higher solids.

Such a practice would result in building up a higher total sludge inventory and reducing the B.O.D. to solids loading. That condition should be avoided. As will be shown, it increases air requirements. It might also create a sludge disposal problem when the index again rose and the excess inventory of sludge had to be dumped over a short period of time. Such a condition could be avoided by continuously operating the return sludge facilities at their maximum capacity, but in a large plant such a procedure might be wasteful of power.

Therefore, if sludge reæration is to be used, provision should be made for introducing variable amounts of settled sewage, digester supernatant, or both, directly to the reæration tank as required.

Such an arrangement also is advantageous in compensating for the unavoidable variations in total B.O.D. load imposed on the plant. It was noted previously that the condition of the sludge, as measured by the Mohlman index, varies over wide limits from day to day at many conventional plants.

Sludge reæration with flexible provision for introduction of nutrients, either sewage or digester liquor, gives the skilled operator a convenient means of controlling such variations. This indicates the superiority of "step æration" as patented by Gould[8], the patented Kraus process[5], or the unpatented Hatfield process over the old-fashioned fixed capacity separate sludge reæration tanks formerly used.

From the viewpoint of construction costs, the principal advantages of sludge reæration are a saving in total æration tank volume and a probable

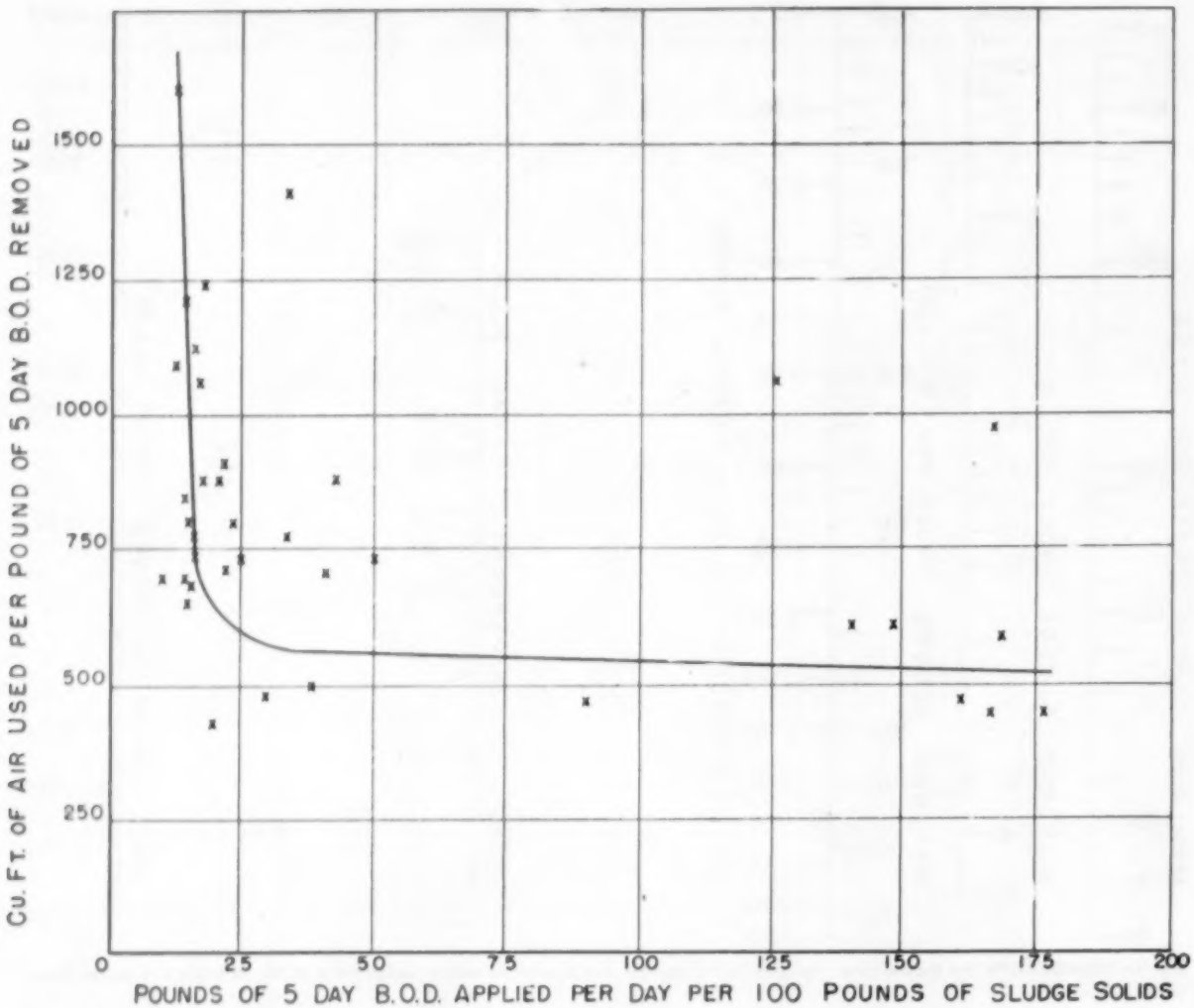


Fig. 4—CORELATION between B.O.D. to solids loading and air consumption per pound of B.O.D. removed

reduction in the required capacity of return sludge facilities.

The disadvantages are the greater complexity of plant piping, and possibly a multiplicity of æration devices or arrangements. (For example, tapered æration may be advantageous in mixed liquor æration, but is of doubtful value in sludge reæration.) These disadvantages are always present.

The advantages become increasingly important when treating high B.O.D. wastes or when a low B.O.D. to solids loading is to be used.

Air Requirements

In diffused air plants, the air is used primarily to (a) mix the contents of the ærator, thus promoting flocculation and preventing sedimentation, and (b) supply the oxygen required for biological oxidation. Since the primary purpose of the activated sludge process is the reduction of oxygen demand, it is logical to relate air supply to B.O.D. removal rather than to volume of sewage. This was done in the newer "Ten State Standards"[2], and in several of the equipment manufacturers' criteria.

Tables 1 and 2 show average air consumption to range from 435 to 1,600 cubic feet per pound of B.O.D. removed. Although there are numerous reasons for this wide range in air requirements, it is believed that one of the major causes is the variation in B.O.D. to sludge solids loading.

In Fig. 4 the air used per pound of B.O.D. removed is plotted against the B.O.D. to solids loading. It will be noted that the air consumption was relatively constant as long as the B.O.D. loading exceeded 35 pounds per day per 100 pounds of sludge solids. It increased rapidly, however, when the loading fell much below 25 pounds.

To understand why such is the case, it is necessary to recall that most of the sewage B.O.D. is quickly adsorbed by the sludge and that it is the subsequent oxidation of the adsorbed material that consumes the oxygen. At B.O.D. loadings of 35 to 50 pounds per day per 100 pounds of sludge solids, oxidation is just barely keeping pace with adsorption. Therefore, a relatively constant relationship between B.O.D. removal and air consumption is to be expected.

However, at materially lower B.O.D. to solids loadings a considerable portion of the sludge is destroyed by "wet combustion." Furthermore, a low B.O.D. to solids loading favors nitrification. Both nitrification and wet combustion require additional oxygen, so air usage per pound of B.O.D. removed from the sewage increases.

At the high B.O.D. to solids load-

ings used in modified æration processes, oxidation lags behind adsorption and sludge is retained in the plant such a short time that one might expect air consumption per pound of B.O.D. removed to drop more than is indicated by Figure 4. Possibly additional data on modified æration would give a different picture. Or, possibly, the decreased efficiency of the only partially activated sludge offsets much of the expected saving in air.

At any event, it is obvious that the capacity of the æration system provided for any activated sludge plant should be based on the B.O.D. to solids loading as well as on the total B.O.D. input. Since sludge reæration makes possible a reduction in total æration tank capacity, and hence in volume of liquor or sludge that must be mixed and agitated, it should result in some slight saving in air requirements.

In view of the many variables and unknowns involved in sewage treatment design, however, this possible saving is believed to be too theoretical to warrant consideration by the designer. The air requirements of a plant designed in accordance with the procedures herein suggested are believed to be practically the same regardless of whether sludge reæration is provided or not.

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Photo courtesy Los Angeles Mirror-News

NOT RAIN, but "fallout" from the 40-foot geyser of water created recently when a careless motorist clipped off a fire hydrant in downtown Los Angeles

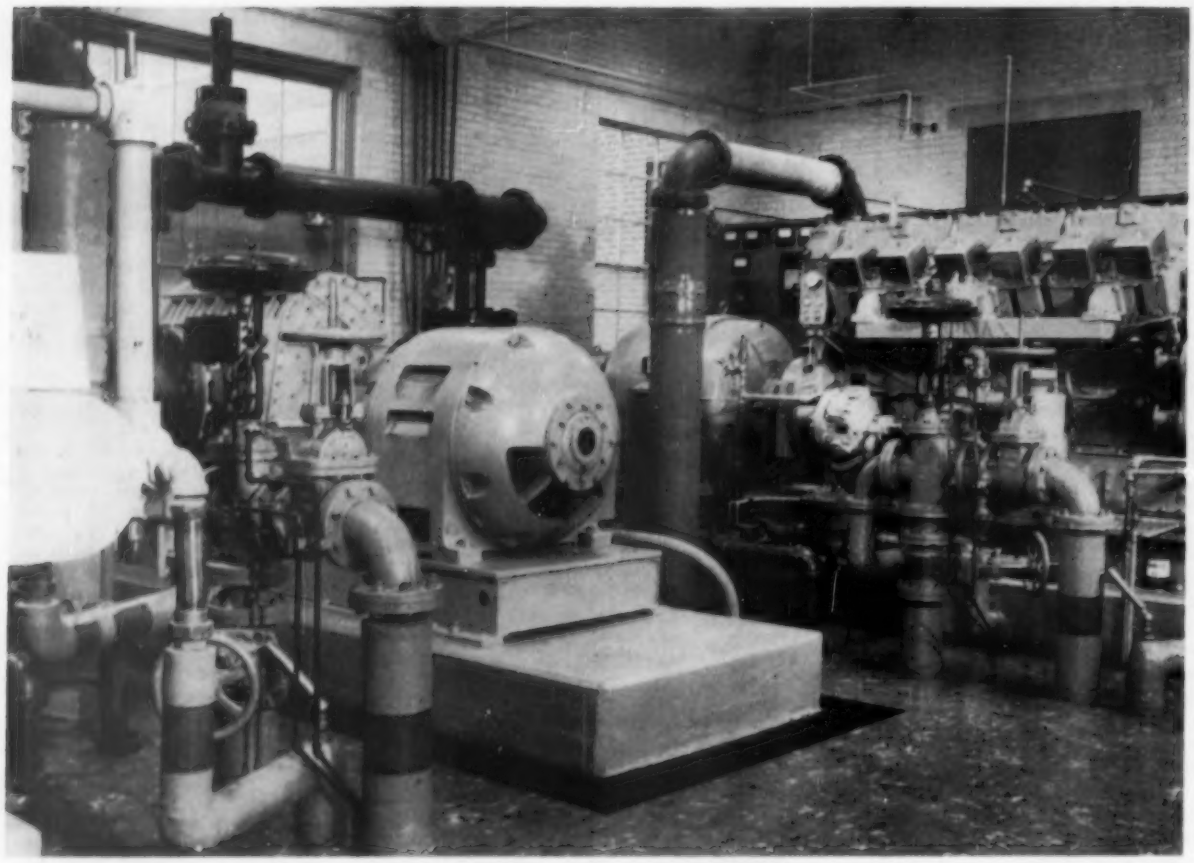

Fig. 1—WASTE HEAT from cooling system of dual-fuel engines and from air blowers is utilized for sludge heating

Waste Heat and Sewage Gas Utilized at York, Pa.

by L. T. TYBURSKI
Field Engineer, The Bristol Company, Waterbury, Conn.

MANY features embodying the latest improvements in the art of sewage treatment have been incorporated in the design and construction of the new sewage treatment plant at York, Pa.

The plant, constructed under the direction of the York City Sewer Authority for the City of York, was dedicated late in 1954. It consists of a sewage treatment works suitable for treating the wastes discharged from some 90,000 persons in York and adjacent municipalities. Also included in the drainage areas are some 400 industries and more than 1000 commercial establishments.

The new plant is designed to handle an average daily sewage flow of 12 mgd, with a maximum flow through the secondary units of 18 mgd. The primary treatment facilities have a capacity of up to 30 mgd.

The plant provides activated sludge treatment with separate sludge digestion and disposal facilities, consisting of fixed cover digestion tanks, elutriation tanks, vacuum filters, and sludge drying and incinerating equipment.

Included in the modern and economical features incorporated in the new plant are the conservation of electric power, the utilization of sludge gas for heating purposes, and the disposal and sale of treated sludge as fertilizer.

One outstanding example of design for economy appears in the utilization of the waste heat of the cooling water from the air blowing engines for preheating the activated sludge. This is accomplished as detailed below.

Air applied to the aeration tank for the activated sludge process, the preaeration tank, and other miscellaneous channel diffusion is generated by three axial flow, screw-type, positive displacement air blowers. The capacity of each blower is 3,500 cfm. Two of these blower units are driven by gas engines which utilize the sewage gas for fuel; the third is driven

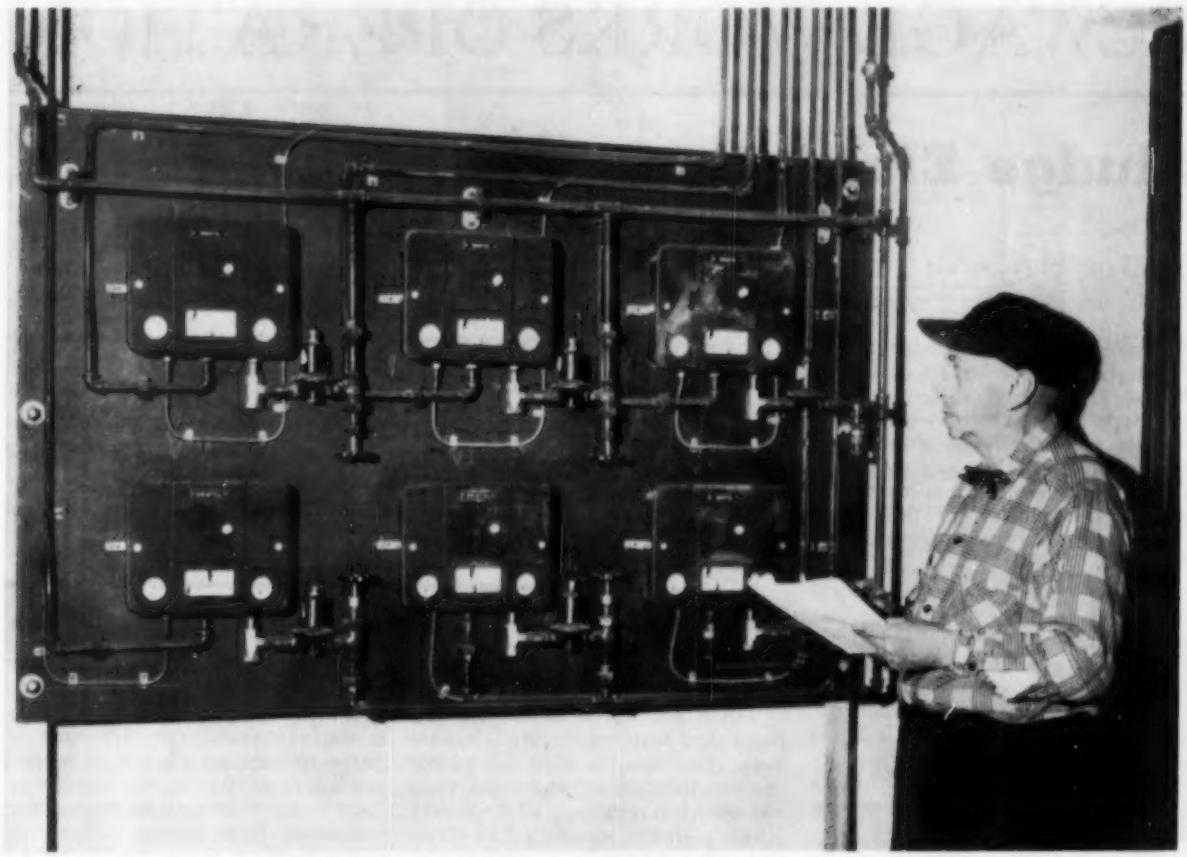

Fig. 2—INSTRUMENT panel units show water and sludge system temperatures and operate pneumatic control and blending valves

by a 150-hp electric motor. The blowers are shown in Figure 1, with the electrically operated unit in the center.

Under normal operating conditions, the gas-engine driven blowers are used, and the electrically driven unit is used only during start-up or when the engine driven blowers are shut down for repairs. This keeps the use of purchased electric power down to a minimum.

The gas-engine driven units are cooled by circulating plant effluent water through the engines and the jacketed exhaust mufflers. The heat thus absorbed is used in heating the sludge in the digestion tanks by circulating it through the preheating units.

Circulation of the water is controlled by a group of Bristol indicating pneumatic temperature controllers actuating three-way water blending valves. Two of these pneumatically operated valves are shown in the foreground in Figure 1. The instrument panel from which these valves are operated is shown in Figure 2.

Circulation water from the gas-engine driven blowers supplies the primary source for preheating the raw sludge and for heating the recirculated sludge. There is a temperature sensing bulb in the outlet of each of the gas engines; the indicating-controller to which each bulb is connected actuates a three-way valve which diverts the circulation water to the sludge preheaters when the temperature reaches 160°F. Some of this water recirculates back to the engine. After giving up some of its heat to the sludge the cooling water reaching the engine is thus always above 145°F. The temperature of the feed water is also controlled by a pneumatically operated proportional flow three-way control valve.

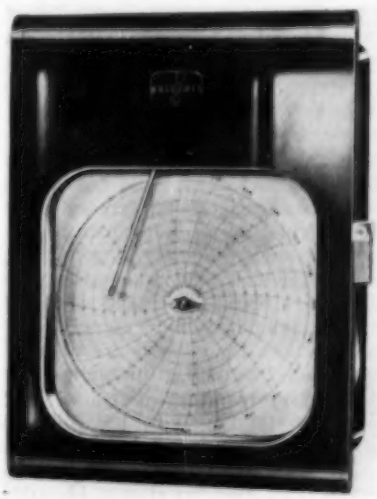

Fig. 3—TYPE of instrument used for recording digester temperatures

In the event that the temperature requirements of the sludge digestion tanks are not satisfied by the circulation water, two hot water boilers having a 1,200,000-Btu capacity have been provided. These have dual-fuel systems for burning sludge gas or oil.

Each digestion tank is equipped with a sludge recirculating pump and a motorized valve. The pump and the valve are actuated by electric indicating temperature controllers by which the sludge is maintained in a temperature range of 86° to 97°F. The actual temperatures in the digesters are recorded on round chart recording thermometers with seven-day charts.

Modern, money-saving equipment such as this is enabling the York City Sewer Authority to operate the new sewage treatment plant in the most economical, efficient method possible.

SEWAGE WORKS OPERATION

Sludge Elutriation

The First of a Series

by THEODORE JAFFE

Mr. Jaffe is Associate Professor of Civil Engineering, Sanitary Research Laboratory, University of Florida, Gainesville, Fla. This is one of a series of articles written by Professor Jaffe for the practical sewage treatment plant operator.

DISPOSAL of the sludge resulting from the treatment of sewage has always been a problem for the plant operator. In a study of Florida sewage plants[1] it was shown that sludge disposal is the concern of more than 50 per cent of the treatment plant personnel, regardless of their titles or the type of treatment provided.

Sewage sludge is disposed of in many ways. Depending upon local conditions it may be dried, burned, or removed as a liquid. No matter what the method of ultimate disposal may be, the operator's prime concern is how small a volume can be produced; the smaller the volume, the lower is the cost of disposal. And what city official would not look with favor upon lower costs, especially for sewage treatment?

To reduce the volume of sludge many devices are employed, depending upon whether the final product is to be disposed of liquid or dry. One of the devices used to produce a dry sludge is vacuum filtration. This method was extremely popular from about 1932 to 1942 and many plants still use this means of producing a relatively dry sludge for final disposal.

In most of the installations, some form of pretreatment of the sludge is required. Chemicals, such as ferric chloride, are often added to the liquid sludge, mixed, and then the "conditioned" sludge is applied to the filter. These chemicals are added to produce a filtered sludge cake containing less water (more solids) and therefore occupying a small volume.

Because the cost of the chemicals is always an additional cost of treatment—and in many cases a high cost—researchers sought ways to improve the efficiency and thus reduce the cost of this method of sludge treatment. Out of this research came sludge elutriation.

What Elutriation Is

Sludge elutriation is a process of adding water or plant effluent to the sludge, mixing thoroughly, allowing the sludge to settle and the liquid to rise. These two portions are then drawn off for further disposal.

There are many mechanical and theoretical features involved, but the basic process is the same. By adding various volumes of water (or plant effluent) two results are accomplished. First, a sludge requiring less chemicals for conditioning is obtained and, second, a more compact sludge with a higher percentage of solids is produced.

Why does the elutriated sludge require less chemicals? Suppose we assume that an operator is using ferric chloride as the conditioner. He uses a chemical to "condition" the sludge for filtration. This means that the filter will do a better job—produce a more compact sludge cake—as a result of adding the conditioner.

The operator knows that in sewage there are colloidal particles and that they are negatively charged, for the most part. He knows, further, that if the charges on these particles are neutralized, the particles will tend to flocculate and then settle out. Since they are negatively charged and since ferric chloride in solution breaks down to something called a ferric ion, each of which has three positive charges, a ferric salt should settle out a large amount of these negative colloids. When the colloids are neutralized it is found that the sludge will compact more readily and lose some of the water bound by the colloidal structure of the sludge.

Knowing this much theory, the operator tries it on his sludge. He adds ferric chloride, mixes it with the sludge and sends it to the filter. No doubt the solids in the cake will improve very little. He adds more chemical and still more, each time getting a slight improvement. The cost of these chemicals, however, soon gets out of proportion to the amount of improvement derived. It appears that something in the sludge is tying up large amounts of the conditioner.

That is exactly what takes place; a large amount of the chemical conditioner is not available for its intended job. This is a costly procedure. What is happening, and what can be done about it?

Quite a few years ago this problem was investigated by many persons. One of these was A. L. Genter, who eventually worked out a patented process of sludge elutriation. Before he obtained the patent, he did a large amount of work and was able to show[2] that this coagulant demand was due to certain substances normally found in sludges and sludge liquors, and that these substances were compounds of ammonia resulting from biological decomposition.

Further, he showed that when water of low alkalinity (titratable alkalinity, not pH) was washed through the sludge, these ammonia compounds would come off with the water and the resulting sludge had a very much smaller coagulant demand. Since the conditioner-grabbing substances were water soluble, the more you wash a sludge, the greater should be the savings in coagulant. This is true up to a certain point, beyond which the savings of chemicals becomes out of balance with the amounts of water required.

Actually, plant effluent has been used successfully in place of water, provided its alkalinity were low. The alkalinity needs to be low since these chemical-grabbing ammonia compounds are more soluble in this type of wash water. In dissolving they increase the alkalinity.

This washing out process, then, is elutriation. What does it do? As previously shown, it decreases the amount of chemical conditioner required for vacuum filtration. Many plants using elutriation report a more rapid filtration of the sludge. Sludge elutriation alone, without the use of chemicals, has been shown to produce a better settling, more compact sludge[3].

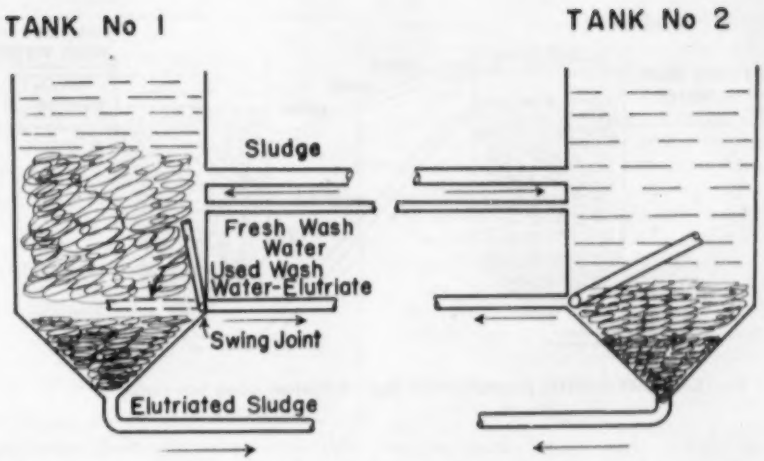

Fig. 1—BATCH process elutriation, using tanks alternately

Methods of Elutriation

Mechanically, several variations of the foregoing process are possible. The elutriation can be done either on a "batch" basis, or a "continuous flow" arrangement.

In the batch process, at least two tanks are required. The sludge is run into the first tank, the wash water is added, and the contents are thoroughly mixed. The mixture is allowed to separate and then the separated portions are drawn off as sludge and elutriate. While the sludge is settling, the second tank is filled, the water added, mixed, and settled. By this time, the first tank is ready to repeat the entire process with a new charge of sludge (see Figure 1).

In a continuous flow arrangement, the entire process occurs in a single tank, in the same manner as sedimentation takes place in a primary or secondary tank. There is an inlet for the sludge, one for the water, a zone of intense mixing, followed by a quiet zone for settling. Again, the end products are a more compact sludge with a smaller coagulant demand, and a liquid portion, both of which need disposal or further treatment (Fig. 2).

To reduce the amount of fresh wash water required in a continuous flow tank, combinations of two tanks may be used for countercurrent elutriation. For this scheme, the sludge and wash waters flow in opposite directions; that is, the unwashed sludge first meets water that has already washed other sludge. As the sludge moves along, it meets fresher water, until at the end of the system the now washed sludge meets the fresh water entering the tank. In other words, the unwashed sludge and the fresh water enter at opposite ends (Fig. 3). After settling, the end products are again the same—a more concentrated sludge and the used wash water.

Elutriation is a practical, workable aid in the sludge disposal problem. It has been used in many treatment plants throughout the country. Just as in every sewage treatment situation, an economic balance must be maintained between the benefits obtained and the cost of these benefits. Phelps[4] has said, "The capital and operating costs of these auxiliary devices (sludge elutriation) must be balanced against the savings in chemical conditioning. The return of elutriation water to the influent of the plant adds to the B.O.D. and solids loads and may further complicate the treatment of the sewage." This statement implies a caution for the treatment works designer as well as the operator. In other words, elutriation must be a planned, integral part of the plant, and not just something stuck in on the spur of the moment.

Factors in Good Practice

Before investigating actual plant results, several of the factors involved in good elutriation practice should be discussed. Elutriation has been tried on fresh raw sludge, old raw sludge, and digested sludge. These have been composed of primary sedimentation sludge alone, mixtures of primary and excess activated sludge, and activated sludge alone.

Genter[2] has shown that due to the digestion process the amounts of ammonia and related amino compounds (these are the coagulant-grabbing substances) are greater in digested sludge than in raw fresh sludge. Since this is so, the relative values of elutriation can be tabulated as follows:

Type of Sludge	*Coagulant Demand*	*Value of Elutriation*
Fresh raw sludge	Least	Greatest
Old raw sludge	More	Less
Digested sludge	Most	Least

The liquid used for elutriation is important. The lower the wash water is in alkalinity, the more effective it will be. A value of 100 ppm alkalinity or less is desirable.

Early experimenters and plant operators used river or lake waters. In many instances, however, this meant either an additional cost for equipment and pumping, or a heavier hydraulic load on the treatment plant, or both.

Later users tried their sewage plant effluent. If the effluent was low in

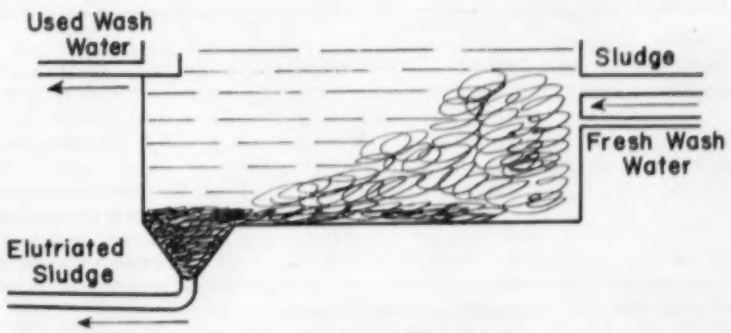

Fig. 2—CONTINUOUS flow elutriation, using single tank

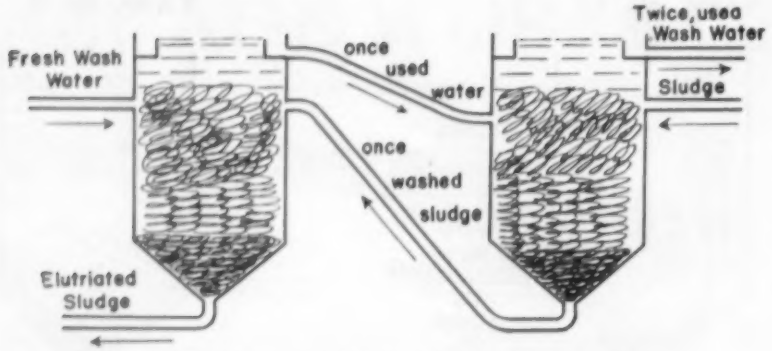

Fig. 3—CONTINUOUS countercurrent flow elutriation using two tanks

alkalinity, this wash water proved effective at lower cost. In some plants it is possible to arrange at least a partial gravity flow system, thus again reducing the pumping costs.

It should be emphasized that where elutriation is used, care must be taken that the additional load due to the wash water pick-up of solids and B.O.D. does not overload a treatment plant.

By careful planning, however, the additional volumes of liquid may be of benefit in some plants due to the diluting effect upon the strength of the raw sewage.

One of the questions that may arise in the operator's mind is, "How much wash water shall I use?" Although the ratio of elutriating water to wet sludge differs from plant to plant, it is commonly assumed that a ratio of 2 or 2.5 volumes of water to 1 volume of wet sludge is a good starting point for a trial in any plant. Why do the ratios vary?

The amount of wash water used depends upon many factors, among which are:

1. What kind of sludge is to be elutriated—raw, digested, primary, secondary, activated or combination?
2. What is the alkalinity of the wash water, and that of the sludge?
3. What is to be done with the sludge after elutriation?
4. How much sludge is to be handled each day?
5. What is the economic point; that is, how much alkalinity should be removed, balanced against the savings derived?
6. How much additional load is the wash water pick-up imposing on the plant?
7. How much detention time is available in the existing plant, or how much additional tank capacity is required.

These factors are interrelated, some working in one direction, some in the opposite. It is agreed that the lower the alkalinity of the wash water, the more times the sludge is washed, the longer it is washed—all these will reduce the coagulant demand and result in a better conditioned sludge. On the other hand, they lead to a greater pickup of B.O.D. and solids in the wash water, greater pumping costs, and require more elutriation and settling tank capacity.

How is an operator to combine these factors into a workable formula? The best answer is to investigate and experiment with his own plant sludge, with the available wash water, and utilizing his own plant facilities. However, as a guide in this direction many plant and laboratory reports have been published (and are included in the references at the end of this article).

Keefer and Kratz[5] have data and charts on various types of sludge and washings; Table 1 is an example of their results. McNamee[6] has published charts showing relative doses of ferric chloride for various degrees of elutriation. He has shown that the amount of ferric chloride required is proportional to the alkalinity of the sludge and sludge liquor. Since elutriation washes out the alkalinity, the more times a sludge is elutriated the smaller the amount of ferric chloride required. From one series of his experiments he has concluded that digested sludge elutriated by countercurrent washing with 2.5 volumes of water can be conditioned with one-third the amount of ferric chloride required if not elutriated.

Craemer[7] reports the results of three years of elutriation experience at the Hartford, Conn., plant and reports, among other things, that elutriation has (a) effected savings in digestion time, (b) eliminated sludge filtration odors, and (c) resulted in a longer life for the filter cloths, as shown in Fig. 4.

Others have published plant results from time to time which can be found in the literature. Two of the most recent are those of Fraschina[8] at the Richmond-Sunset plant at San Francisco, Calif., and Sparr[9] at the East Rockaway, N. Y., plant. Fraschina apparently is very well pleased with elutriation. Sparr presents certain formulas to relate the quality of the elutriation tank effluent and three factors—the dry solids loading, the volatile content of the sludge, and the liquid detention time. Among the results of his plant-scale study he cautions that the quality of the elutriator effluent be "seriously considered if detrimental high solids recirculating loads are to be avoided."

In an attempt to formulate the coagulant requirements for sludge elutriation, Genter[10] combined the liquid portion and solids portion requirements. His equation may be written:

Use of Equation

To illustrate how the foregoing equation is used, assume a sludge, be-

TABLE 1

Elutriation of Digested Thickened Sludge

Vol. of Wash Water	Ferric Chloride[a]	Filter Capacity[b]	Saving
0	6.0	10.2	—
1	6.0	26.6	2.6 × filter capacity
0	4.7	5.9	—
3	4.0	28.8	5 × filter capacity with 15 percent less coagulant
0	5.4	8.0	—
3	1.6	8.0	70 percent less coagulant

[a] Pounds $FeCl_3$ per 100 pounds dry solids in sludge
[b] Pounds dry solids in cake per square foot of filter area per hour

$$\% \text{ chemical } (FeCl_3) = 1.08 \times \frac{0.0001 \times \text{alka. sludge moisture (ppm)} \times \% \text{ sludge moisture}}{(1 - \% \text{ sludge moisture}) \text{ or } (\% \text{ total solids})} + 1.6 \frac{\% \text{ volatile matter}}{\% \text{ fixed matter}}$$

All these values are on a dry basis. In terms of the usual sludge analysis this equation may be somewhat simplified to:

$$\% \ FeCl_3 = 0.000108 \times \text{alkalinity (ppm)} \times \frac{\% \text{ water}}{\% \text{ solids}} + 1.6 \frac{\% \text{ volatile}}{\% \text{ ash or fixed}}$$

Fig. 4—GENTER method of calculating coagulant requirements

fore elutriation, of 4 per cent total solids and 55 per cent volatile solids having an alkalinity of 3,000 ppm. After elutriation, the alkalinity has been reduced to 250 ppm. How much (%) $FeCl_3$ is required before and after elutriation?

If 4% total solids, then (100% — 4%) = 96% moisture.

If 55% volatile solids, then (100% — 55%) = 45% fixed solids.

$$\% \ FeCl_3 = 0.000108 \times 3000 \text{ ppm} \times \frac{96}{4} + 1.6 \frac{55}{45}$$

$$= 0.000108 \times 3000 \times 24 + 1.6 \ (1.22)$$

$$= 9.73\%$$

$$\% \ FeCl_3 = 0.000108 \times 250 \text{ ppm} \times \frac{96}{4} + 1.6 \frac{55}{45}$$

$$= 2.60\%$$

It must be pointed out that the equation is only a guide for the operator. He must determine the best dosage for his particular situation. Some of the factors will be:

1. Amount of alkalinity removed by elutriation.

2. Type of sludge to be filtered, as previously discussed (raw or digested; primary, secondary, or combinations).

3. Whether the sludge contains any industrial wastes that react with the coagulant (iron reducing compounds, mineral or cutting oils, etc.).

4. What degree of dewatering is expected of the filter (% moisture in the cake).

5. Operation of the filter (speed of revolution, type of filter cloth, etc.).

6. The coagulant used (ferric chloride, alone or with lime; chlorinated copperas, ferric sulfate, etc.).

7. If digested sludge, the degree of digestion is important (% vol./% fixed).

As a first attempt at determining how much wash water is to be used, the formulas of Genter[11] can be used. If single-stage elutriation is used the ratio, R, of wash water to sludge is:

$$R = \frac{D - E}{E - W}$$

For any number of stage washings, n, (more than 1), the ratio for each wash is:

$$R = \sqrt[n]{\frac{D - W}{E - W}} - 1$$

For countercurrent washing (two tanks), the ratio is:

$$R = \sqrt{\frac{D - E}{E - W}} + .025 - 0.5$$

in which

D = alkalinity of the sludge before elutriation;
E = alkalinity of the elutriated sludge;
W = alkalinity of the elutriating (wash) water or effluent; and
R = ratio of volumes of elutriating water to the volume of moisture in the sludge.

In the foregoing formulas R is the ratio of the volume of water to the volume of moisture in the sludge. The operator, however, wants to know the volume of water to the volume of sludge (not moisture). Therefore, R must be multiplied by the fraction of water in the sludge.

Incidentally, much has been said regarding the alkalinity of the sludge. How is this determined in the plant? The standard method for running sludge alkalinity is given on page 349 of the Tenth Edition and page 158 of the Ninth Edition of "Standard Methods"[12]. While this is a relatively simple procedure, the end point of the titration may be somewhat difficult to see at first.

With practice, though, any operator soon will be able to detect the correct end point. A fluorescent light over the titration will help, as will doing the titration over a white table top. If a pH meter is available, this can be used to indicate the titration end point with no need to watch for color changes.

The foregoing discussion has been concerned primarily with sludge elutriation as an aid in conditioning sludge for vacuum filtration. Recently, interest in elutriation has been revived as a means of sludge thickening and as an aid in two-stage digestion. These will be discussed in the next article of this series, "Recent Advances in Sludge Digestion."

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[11] Ibid, p. 651.

[12] "Standard Methods for the Examination of Water, Sewage, and Industrial Wastes." Amer. Public Health Assn., New York, N. Y., Tenth Edition 1955.

Let's Go Back To School

Some thoughts on adult education in the field of water and sewage works

Dear Bill,

"There are more people registered in adult education courses than there are children in the regular school systems."—That was what I heard over the radio not long ago.—Remember when we were kids in school, we used to say, "Boy, when I get out of here, I'll never look at another book." Actually, of course we've studied more books since leaving school than we ever did while there.

I got to thinking about this matter of adult education and what it means to all of us in the water and sewage field. For one thing, the advent of the age of atomic energy has presented us all with something, not only new, but highly technical and extremely important. But there is more to our need for continued education either by our own program or through some organized schooling system. Aside from atomic energy problems, our industry is growing and becoming more complex with new ideas, new approaches, new operations, new advances in laboratory techniques, and new equipment.

Back To School

There is only one way we can keep up with this changing world of ours, and that is to continue our education, In effect, we must continue to go to school, one way or another. For the benefit of my men, as well as for myself, I've been thinking of the various methods by which we can "go back to school." Perhaps you may be interested in some of my thoughts.

For our personal program, the articles published in current technical magazines offer the latest information on how other people are attacking problems like ours, and on new ideas, research, and new techniques. In this category of schooling, I include the *AWWA Journal, Sewage and Industrial Wastes Journal,* and *Water & Sewage Works,* for example.

One evidence of the interest in this business of continuing our education is the way technical magazines (not only in our field but in other fields), are running series of articles on fundamentals. Some call them "refresher courses," others call them "lectures in practice," etc., but they all have one thing in common. They are written to educate men in the field. The series of articles on "Safety" in recent issues of the *AWWA Journal* is a good example of this approach.

Some magazines publish annual issues in which the most useful technical articles are reprinted from the past year along with other basic information on various phases of our business, or information on equipment fundamentals, etc. One of these is the Annual Reference and Data Edition of *Water & Sewage Works.*

More extensive personal study can make use of various textbooks which are published each year. Most of these are written for college students and may be too technical for operators who have not had extensive formal education, but these books should be a part of a superintendent's reference library.

Convention Schools

When you stop and think about it, conventions and technical meetings are schools in the broader sense. Of course, most of the papers presented at these meetings are published later, but there is much to be said for education by listening to some one present a paper, if he doesn't bury his nose in the paper and read in a deadly monotone. And there's the discussion and question and answer period. The latter can be the most educational part of a technical session if handled properly—and it doesn't get printed in the official journals.

More in the vein of a school are the various forums and symposia which are generally devoted to a single topic with well informed persons taking part in the discussion. These forums become even more educational when the "board of specialists" serves as a panel to answer questions from the audience.

Within the past several years a more definite "school" at conventions has made its impact felt. Probably the first water works organization to adopt the "school" idea was the New England Water Works Assn.

More recently, the New York Section of AWWA has started a "water works school" as a part of its regular meetings. The idea for this school was first presented at a meeting of the N. Y. Section in April 1954 and received enthusiastic approval. Since then three "schools" have been held (the N. Y. Sect. meets twice a year). At each session of the school, the leader presents a short lecture on fundamentals of the particular topic under discussion and then introduces two other specialists to expand on some particular phase of the topic. Following each talk, the leader conducts a question and answer period.

The interest and popularity of this school is evidenced by the fact that although it is held the first thing on the first morning of the meeting, and that although that time period had never been used before at meetings of the section, these past three schools have drawn more attendees than the other sessions of the meetings.

Short Schools

Still more formal schools are held throughout the country, under the auspices of various colleges and universities. Many of these schools are sponsored by health departments and by sections of AWWA and FSIWA. According to my last count, there were at least 29 of these schools in the water works field. Of these, five are joint water and sewage schools with sectional associations meetings. In addition, there are at least 18 sewage works short schools from Alabama to Wisconsin.

I guess you'll agree with me that if a fellow wants to "go back to school" he can do it in several ways depending on what he wants. Not any of these forms of adult education are expensive but they are highly beneficial to a man in his job.

Yours, Jim

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*The application of the equipment, as well as the equipment itself is covered by U.S. Patents No. 2,532,457, No. 2,144,385, No. 2,328,655 and No. 2,555,201.

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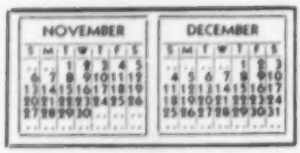

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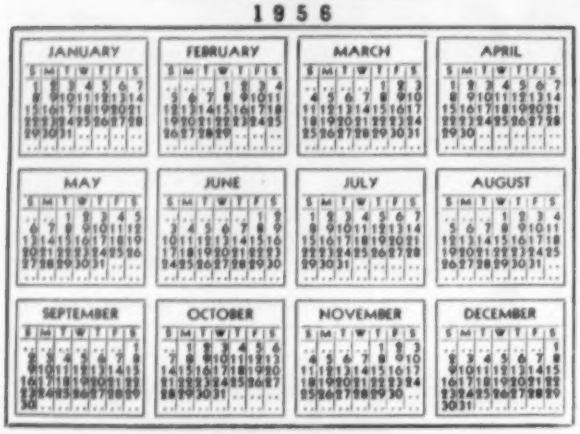

Nov. 3-5—State College, Pullman, Washington
FOURTH BIENNIAL INLAND EMPIRE WATER WORKS SCHOOL, Prof. G. H. Dunstan, State College of Washington, Pullman, Washington.

*Nov. 3-5—Roanoke, Va. *(Hotel Roanoke)*
VIRGINIA SECTION A.W.W.A., Secy. J. P. Kavanagh, 213 Carlton Terrace Bldg., Roanoke, Va.
* This is a correction from previous listing.

Nov. 6-9—Orlando, Fla. *(Orange Court Hotel)*
FLORIDA SECTION A.W.W.A. Sec'y, Harvey T. Skaggs, P.O. Box 2328, Jacksonville, Fla.

Nov. 6-9—Orlando, Fla., *(Orange Court Hotel)*
FLORIDA SEWAGE & INDUSTRIAL WASTES ASSOCIATION (Annual Meeting) Sec'y-Treasurer, M. E. Dawkins, P.O. Box 210, Jacksonville, Fla.

Nov. 14-16—St. Louis, Mo. *(Chase Hotel)*
CONCRETE PIPE SHORT COURSE (Annual), Howard F. Peckworth, American Concrete Pipe Assn., 228 N. LaSalle St., Chicago 1, Ill.

Nov. 14-16—Winston-Salem, N. C. *(Robert E. Lee Hotel)*
NORTH CAROLINA SECTION A.W.W.A., Secy. Wilber E. Long, Jr., 1616 Bickett Blvd., Raleigh, N. C.

Nov. 14-16—Winston-Salem, N. C. *(Robert E. Lee Hotel)*
NORTH CAROLINA SEWAGE & INDUSTRIAL WASTES ASSOCIATION, W. E. Long, Jr., Sec.-Treas., Box 2091, Raleigh, N. C.

Nov. 14-18—Kansas City, Mo. *(Municipal Auditorium)*
AMERICAN PUBLIC HEALTH ASSOCIATION (83rd Annual Meeting). Exec.-Sec'y, Dr. Reginald M. Atwater, 1790 Broadway, New York, N. Y.

Nov. 16-18—Allerton Park, Ill. *(Univ. of Illinois)*
WATER WORKS MANAGEMENT SHORT COURSE, Director Dr. T. E. Larson, State Water Survey, Urbana, Ill.

Nov. 21-22—Kansas City, Mo. *(Continental Hotel)*
KANSAS CITY HYDRAULICS CONFERENCE, Kansas City Section A.S.C.E., Glenn C. Gray, Publicity Chairman, 19 East Gregory Blvd., Kansas City 14, Mo.

(Continued on page 90A)

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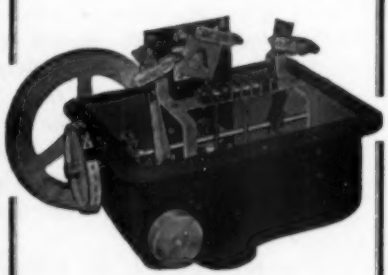

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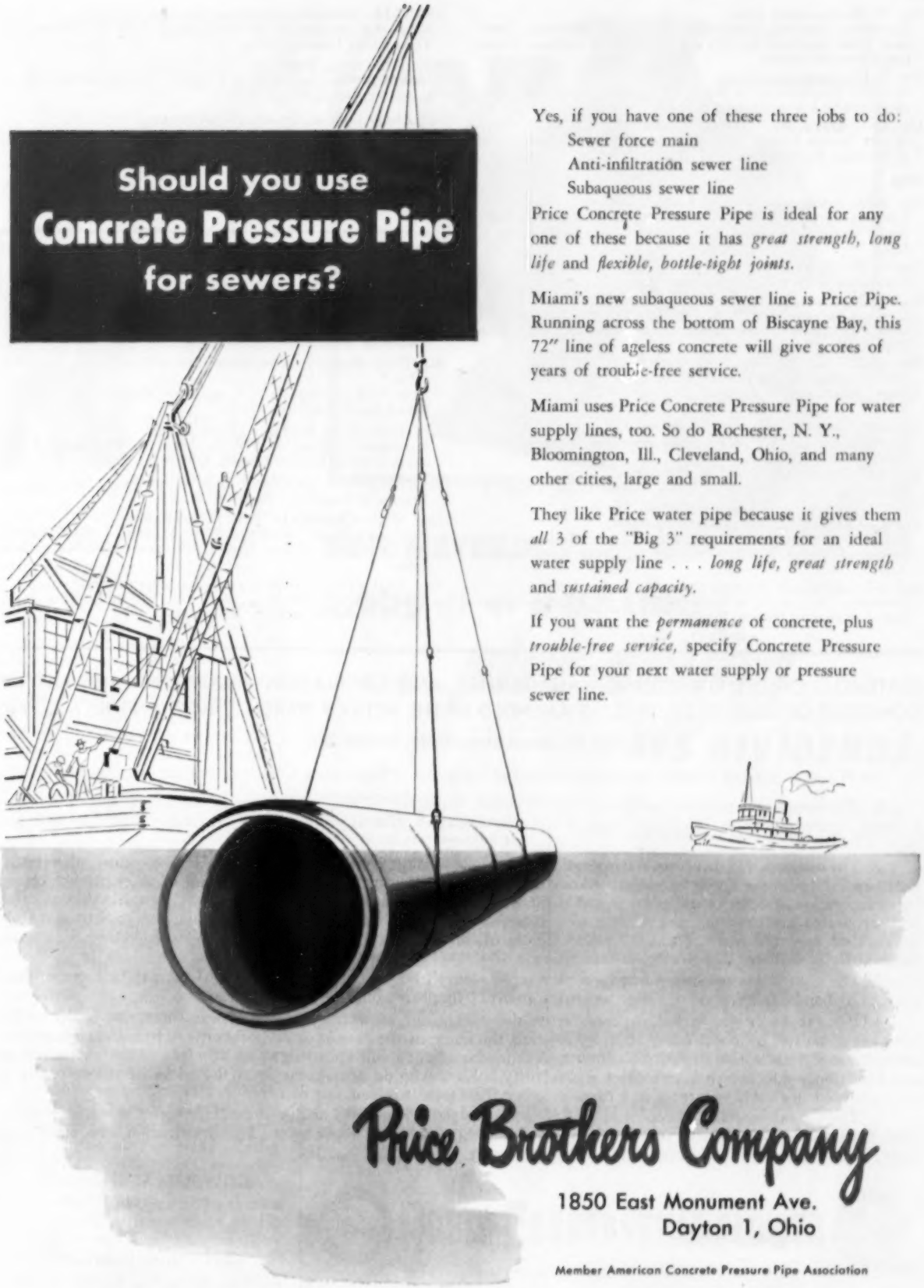


Should you use Concrete Pressure Pipe for sewers?

Yes, if you have one of these three jobs to do:

Sewer force main
Anti-infiltration sewer line
Subaqueous sewer line

Price Concrete Pressure Pipe is ideal for any one of these because it has *great strength, long life* and *flexible, bottle-tight joints.*

Miami's new subaqueous sewer line is Price Pipe. Running across the bottom of Biscayne Bay, this 72″ line of ageless concrete will give scores of years of trouble-free service.

Miami uses Price Concrete Pressure Pipe for water supply lines, too. So do Rochester, N. Y., Bloomington, Ill., Cleveland, Ohio, and many other cities, large and small.

They like Price water pipe because it gives them *all* 3 of the "Big 3" requirements for an ideal water supply line . . . *long life, great strength* and *sustained capacity.*

If you want the *permanence* of concrete, plus *trouble-free service,* specify Concrete Pressure Pipe for your next water supply or pressure sewer line.

Price Brothers Company

1850 East Monument Ave.
Dayton 1, Ohio

Member American Concrete Pressure Pipe Association

Concrete Pressure Pipe for Water Supply, Subaqueous, Pressure Sewer and Culvert Installations

Nov. 27-30—Cleveland, Ohio
NATIONAL CHEMICAL EXPOSITION, at Public Auditorium, Cleveland, Ohio, sponsored by Chicago & Cleveland Sections, American Chemical Society.

Dec. 11-17—Cleveland, Ohio
NUCLEAR ENGINEERING & SCIENCE CONGRESS, Cleveland, Ohio, sponsored by Engineers Joint Council.

Dec. 14—Augusta, Me.
MAINE WATER UTILITIES ASSOCIATION. Sec'y, Earle A. Tarr, 15 Bowdoin St., Winthrop, Me.

1956

Feb. 8-10—Indianapolis, Indiana *(Lincoln Hotel)*
INDIANA SECTION, A.W.W.A., Secy., Robert J. Becker, Indianapolis Water Company, 113 Monument Circle, Indianapolis 6, Ind.

Feb. 13-17—Dallas, Texas
AMERICAN SOCIETY CIVIL ENGINEERS

Mar. 21-23—Chicago, Illinois *(LaSalle Hotel)*
ILLINOIS SECTION, A.W.W.A., Secy., Dewey W. Johnson, Cast Iron Pipe Research Association, 122 So. Michigan Ave., Chicago 3, Ill.

Mar. 18-21—Augusta, Georgia *(Bon Air Hotel)*
SOUTHEASTERN SECTION, A.W.W.A., Secy., N. M. deJarnette, Engr., State Dept. Pub. Health, 245 State Office Bldg., Atlanta 3, Ga.

Apr. 4-6—Topeka, Kansas *(Jayhawk Hotel)*
KANSAS SECTION, A.W.W.A., Secy., Harry W. Badley, 119 W. Cloud, Salina, Kansas.

Apr. 5-6—Chapel Hill, N. C.
FIFTH SOUTHERN MUNICIPAL & IND. WASTE CONF., Daniel A. Okun, Univ. of North Carolina, Chapel Hill, N. C.

Apr. 5-7—Safford, Arizona *(Hotel not selected)*
ARIZONA SECTION, A.W.W.A., Secy., Quentin M. Mees, Ariz. Sewage & Water Works Assn., 721 N. Olson Ave., Tucson, Ariz.

Apr. 6-7—Livingston, Montana *(Lincoln Hotel)*
MONTANA SECTION, A.W.W.A., Secy., A. W. Clarkson, State Board of Health, Helena, Montana.

Apr. 11-13—Nebraska *(Hotel and City not selected)*
NEBRASKA SECTION, A.W.W.A., Secy., John E. Olsson, 922 Trust Bldg., Lincoln, Nebr.

Apr. 18-20—Utica, New York *(Hotel Utica)*
NEW YORK SECTION, A.W.W.A., Secy., Kimball Blanchard, 56 Grand St., White Plains, N. Y.

Apr. 23-25—London, Ontario *(Hotel London)*
CANADIAN SECTION, A.W.W.A., Secy., A. E. Berry, 72 Grenville St., Toronto, Ont., Canada.

Apr. 26-28—Victoria, B. C. *(Canada Empress Hotel)*
PACIFIC NORTHWEST SECTION, A.W.W.A., Secy., Fred D. Jones, Distr. Supervisor, Rm. 305, City Hall, Spokane, Wash.

May 6-11—St. Louis, Mo. *(Hotel not selected)*
A.W.W.A. CONVENTION, Secy., Harry E. Jordan, A.W.W.A. Assn., 521 Fifth Ave., New York 17, N. Y.

June 4-8—Knoxville, Tenn. *(Hotel not selected)*
AMERICAN SOCIETY CIVIL ENGINEERS

Sep. 12-14—Bolton Landing, Lake George, New York *(Sagamore Inn)*
NEW YORK SECTION, A.W.W.A., Secy., Kimball Blanchard, 56 Grand St., White Plains, N. Y.

Sept. 12-14—Flint, Michigan *(Durant Hotel)*
MICHIGAN SECTION, A.W.W.A., Secy., T. L. Vander Velde, Mich. Dept. of Health, Lansing 4, Mich.

Sept. 16-20—NEW ENGLAND WATER WORKS ASSN., Secy., Geo. C. Bogren, 14 Beacon St., Boston 8, Mass.

Sept. 17-19—Chattanooga, Tenn. *(Hotel Patten)*
KENTUCKY-TENN. SECTION, A.W.W.A., Secy., J. Wiley Finney, Jr., Tenn. Dept. of Pub. Health, 420 6th Ave. N, Nashville 3, Tenn.

Sept. 19-21—Toledo, Ohio *(Commodore Perry Hotel)*
OHIO SECTION, A.W.W.A., Secy., M. E. Druley, Dist. Mgr., Dayton Power & Light Co., Wilmington, Ohio.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946

(Title 39, United States Code, Section 233)

Of Water & Sewage Works, published monthly at Lafayette (Tippecanoe County), Indiana, for October, 1955.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Edward Scranton Gillette, 185 North Wabash Avenue, Chicago 1, Illinois; Editor, Linn H. Enslow, 155 East 44th St., New York 17, N. Y.

2. The owner is (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.): Scranton Publishing Company, 185 North Wabash Avenue, Chicago 1, Illinois; E. S. Gillette, 185 North Wabash Avenue, Chicago 1, Illinois; C. T. Gillette, 185 North Wabash Avenue, Chicago 1, Illinois.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

EDWARD S. GILLETTE
(Signature of Publisher)

Sworn to and subscribed before me this 18th day of October, 1955.

[SEAL]

SARAH ROSE DABRIN
(My commission expires March 31, 1956)

SPILLWAY

"Sam" Morris Honored Upon Retirement

Samuel B. Morris, for the past eleven years Chief Engineer and General Manager of Los Angeles' Dept. of Water and Power, at 65 reached the mandatory retirement age on October 1, 1955, the date of his retirement. His services, however, will not be completely lost to the Department which has placed Mr. Morris on a retainer for special services in connection with atomic power development and planning future water supply sources for Los Angeles.

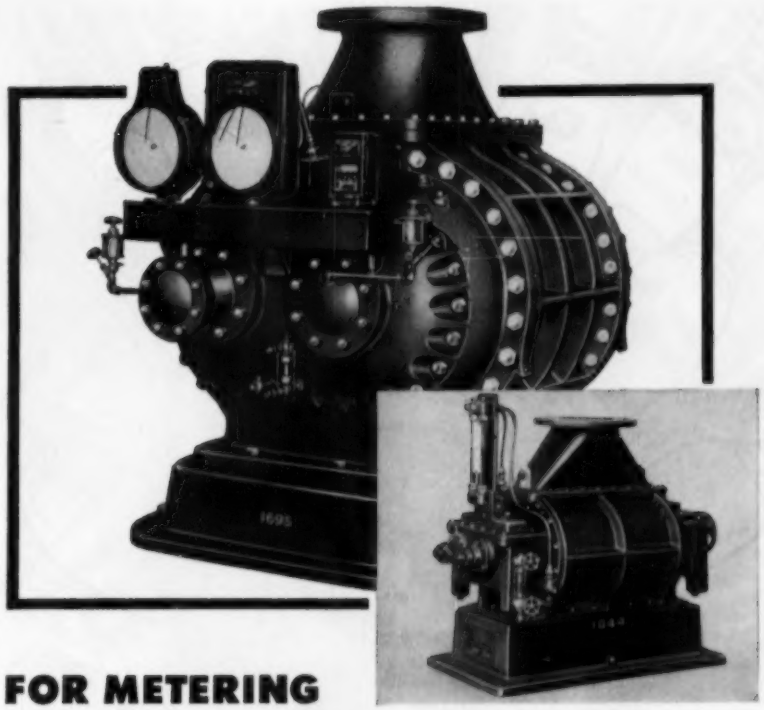
"Sam" Morris' retirement was the occasion for a tremendous demonstration of the esteem in which he is held. A special civic luncheon given in his honor was participated in by 850 prominent citizens, public officials and friends. Telegrams came from former president Herbert Hoover, Vice President Nixon, Senator Knowland, Sec'y of the Navy Thomas, Governor Knight and many others of high office.

The City of Los Angeles presented to Mr. Morris a scroll of appreciation for his civic service. B. P. Griffith, president of the Board of Water & Power Commissioners, in his praise of "Sam" Morris, pointed out the ease of securing development money under his management because the nation's leading financial houses considered the Los Angeles water and power utility the most efficiently operated in the country.

Citing the growth of the utility during Morris' eleven year service as general manager (1944-1955) its assets had increased from $368,871,000 to $707,000,000. Income from sales of water and power had increased during these eleven years from $54,000,000 to $100,000,000 annually.

In his customarily modest fashion Mr. Morris, in a brief thank-you speech, pointed to the wisdom of the "founding fathers" back in 1902 when establishing the Dept. of Water & Power as separate from other municipal operations under a Board of Com-

(Continued on page 92A)



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Look for R-C plur-ability in all your equipment to handle gas and air

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Ask for detailed bulletins on any R-C product—or write us your needs.

Packed into every Roots-Connersville Positive Displacement Gas Meter for measuring sludge gas are important values which mean *"plur-ability."* Summed up, they give you accuracy unmatched by any other type—that endures over many years of use. Maintenance is practically unknown, with no vanes, valves, or small parts. Compactness saves space and foundation cost. Capacities, pressures and overload ability fit your most exacting needs. If you need to measure sludge gas from 5,000 cfh to a million, you can trust the staying qualities of R-C Positive Displacement Meters. Ask for details in Bulletin M-152.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

1155 Mount Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto, Ont.

Get All The Advantages With Ferri-Floc

You can depend on Ferri-Floc to give smoother, more efficient and trouble-free coagulation. Whatever your specific water treatment problem may be, you can depend on Ferri-Floc to do the job adequately, efficiently and economically. Ferri-Floc is a free-flowing granular salt which can be fed with a few modifications through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy and safe handling as well as storage in closed hoppers over longer periods of time.

WATER TREATMENT

Ferri-Floc coagulates surface or well waters, and it aids taste and odor control. It is effective in lime soda-ash softening, and is adaptable to treatment of practically all industrial water or wastes.

SEWAGE TREATMENT

Ferri-Floc coagulates waters and wastes over wide pH ranges. It provides efficient operation regardless of rapid variations of raw sewage, and is effective for conditioning sludge prior to vacuum filtration or drying on sand beds.

SULFUR-DIOXIDE is effectively used for dechlorination in water treatment and to remove objectionable odors remaining after purification.

SULFUR-DIOXIDE HIGHEST QUALITY SO_2

COPPER SULFATE

COPPER SULFATE will control about 90% of the microorganisms normally encountered in water treatment plants more economically than any other chemical.

FREE NEW BOOKLET: Let us send you without charge a 38-page booklet that deals specifically with all phases of coagulation. Send postal card to—

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617-629 Grant Building, Atlanta, Ga.

missioners given broad powers. Much emphasis was placed by Mr. Morris on the fact that water and power funds had always been kept separate from other city funds. In consequence, said he, "it has always been possible to budget and plan long-range expansion programs that have kept our system facilities well ahead of the demands for our services. As a result, we have always had ample water and electricity for our customers, whenever they wanted it and in whatever quantity needed."

Mr. Morris' successor as general manager and chief engineer of the Los Angeles Dept. of Water & Power is William S. Peterson, about whom Mr. Morris had some nice things to say.

F. W. Gilcreas Joins Staff of University of Florida

Appointment of F. W. Gilcreas as Professor of Sanitary Science was recently announced by the College of Engineering, University of Florida. Professor Gilcreas was formerly Assistant Director in Charge of the Division of Laboratories and Research, New York State Department of Health. He received his training in chemistry at Harvard University.

Mr. Gilcreas is well known for his pioneering work in developing new analytical procedures in sanitary chemistry. His contributions have been presented in more than 75 technical papers, including two series which were published in book form. In his new position he will be engaged in research and teaching in several fields of sanitary science.

Among the important committee chairmanships held by Mr. Gilcreas has been that of the APHA Committee on Standard Methods for the Examination of Water and Sewage. This committee has recently completed the monumental task of publishing the 10th edition of "Standard Methods." He also served for many years as chairman of the FSIWA Publications Committee, in which capacity he was primarily responsible for the technical programs of the Federation's annual meetings.

Mr. Gilcreas has also been a member of the faculty of the Albany (N. Y.) Medical School and a consultant to the Division of Environmental Sanitation, World Health Organization.

In SOUTH AFRICA too . . .

TYLOX
Rubber
PIPE JOINTS

are specified to make waste lines

- ★ ***LEAK-PROOF***
- ★ ***CORROSION-RESISTANT***
- ★ ***LONG-LASTING***

Here, a native African installs high pressure TYLOX Gaskets (bell assembly type) shipped from half way around the world to couple this pipe and protect its joints against leakage and acid attack.

The project, at Sasolburg, Orange Free State, South Africa, called for over 50,000 feet of TYLOX-jointed pipe for disposal of *both* sewerage and industrial wastes. It was a joint project of the Town of Sasolburg, and The South African Coal, Oil and Gas Corporation, Ltd. Pipe was manufactured and laid by The Roberts Construction Company, Ltd.

The question "what joint?" for this double-duty line was quickly resolved by the designers . TYLOX — which cuts construction costs by speeding pipe work, leak-proofs joints by its compression seal, and never deteriorates because of the special compounding of its rubber — was the *only* pipe joint fully meeting their requirements for pipe line economy, safety and longevity. And they were willing to go half the world away to get it.

WRITE FOR OUR NEW TYLOX BOOKLET . . .

. . . read the facts on TYLOX, the only flexible joint meeting requirements of designer, builder and taxpayer alike. See why TYLOX is specified for big, important pipe jobs all over the world. Specify TYLOX to assure economy, safety and longevity on your pipe projects.

HAMILTON KENT MANUFACTURING COMPANY

KENT, OHIO

427 West Grant St. Orchard 3-9555

5012

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W&SW

New Equipment

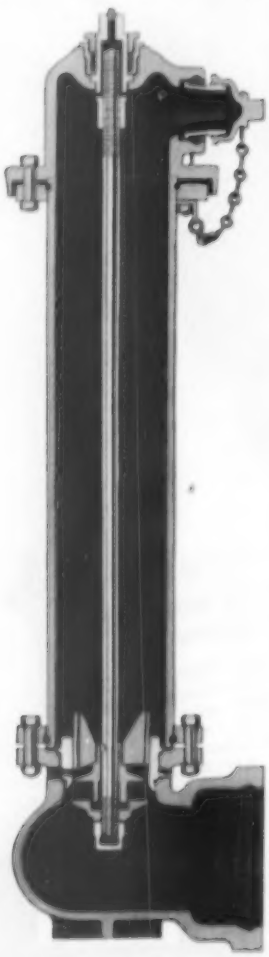
Desurger Eliminates Water Hammer

1101

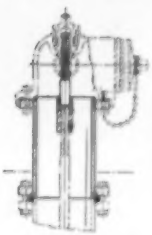
Westinghouse Air Brake Company, Industrial Products Div., Wilmerding, Pa., has available the Westinghouse Desurger that prevents water hammer by keeping pressure surges and pulsations from growing into destructive forces.

The Desurger gets its high efficiency from its in-line double acting construction which places every drop of liquid under constant control. This in-line construction also gives it a compact space saving shape, and simplifies maintenance. Desurgers have only one wearing part—the sleeve—which is easily replaced. They are currently available in pipe sizes from 1 inch to 4 inch diameter.

COSTS LESS TO INSTALL
COSTS LITTLE TO MAINTAIN



A community can rest easy when it is protected by R. D. Wood Swivel-Joint Hydrants. Trouble can be a long time coming, but when it comes these great hydrants are ready. Installation and maintenance costs are low. They work instantly, reliably. Water-carrying areas are generously sized for full flow and maximum pressure. Every point of friction is protected by at least one bronze surface. Accurately formed threads and fitted parts make them interchangeable with other hydrants of the same size. Compression-type valve stops leakage when hydrant is broken in traffic accident.



Extension piece can be inserted between hydrant head and barrel, or between barrel and elbow, without shutting off water supply.

Breakable flange and stem coupling can be furnished at extra cost. Both are constructed so that a heavy blow will snap the ring and coupling, thus saving more costly damage to the hydrant itself. Both can be replaced quickly and inexpensively with spares. No digging necessary.

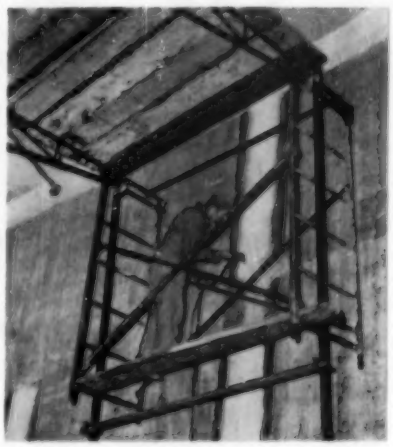
R.D. Wood Swivel Joint Hydrants

Public Ledger Building, Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R.D. Wood Gate Valves

Send for this 80-page catalog. It contains full information about the R. D. Wood line of Cast Iron Pipe, Fire Hydrants, Gate Valves, and Hydraulic Machinery.

Plastic Coating Stops Reservoir Leakage



1102

Surface Engineering Co., Inc., Wichita, Kans., has announced that their Secoton coatings, based on Bakelite vinyl resins, was used to stop excessive water seepage through the expansion joints of a new 25,000,000-gallon reservoir at Omaha, Neb.

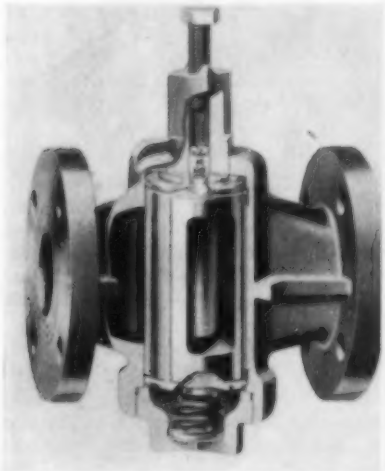
When the reservoir was built, a total of 12 to 15 G.P.M. of water loss was anticipated. Upon filling the reservoir the catch basin system became completely saturated, with many times the anticipated amount of water loss, both through the floor system and walls of the reservoir.

The trouble was due to the fact that the normal mean temperature of the structure surfaces was 56°F, and that the water being pumped into the storage unit was an exceptionally cold 34°F to 40°F. The result was a sudden contraction of the individual wall segments, causing the expansion joints to open, releasing large volumes of water.

The use of Secoton elastic coating to seal the expansion joints in the res-

ervoir did not interfere with the expansion and contraction of the tank surfaces and reduced the water loss to a trickle of 1½ to 2 G.P.M.

Lubricated Plug Valve



1103

Homestead Valve Manufacturing Co., Coraopolis, Pa., has developed a new lubricated plug valve rated at 200 pounds oil-water-gas, in sizes up to 20 inches.

Some of the features of the valve are: positive high pressure distribution of lubricant over the entire sealing surface; a self-freeing plug to prevent sticking; and ease of operation of a cylindrical plug valve.

Filter Control System

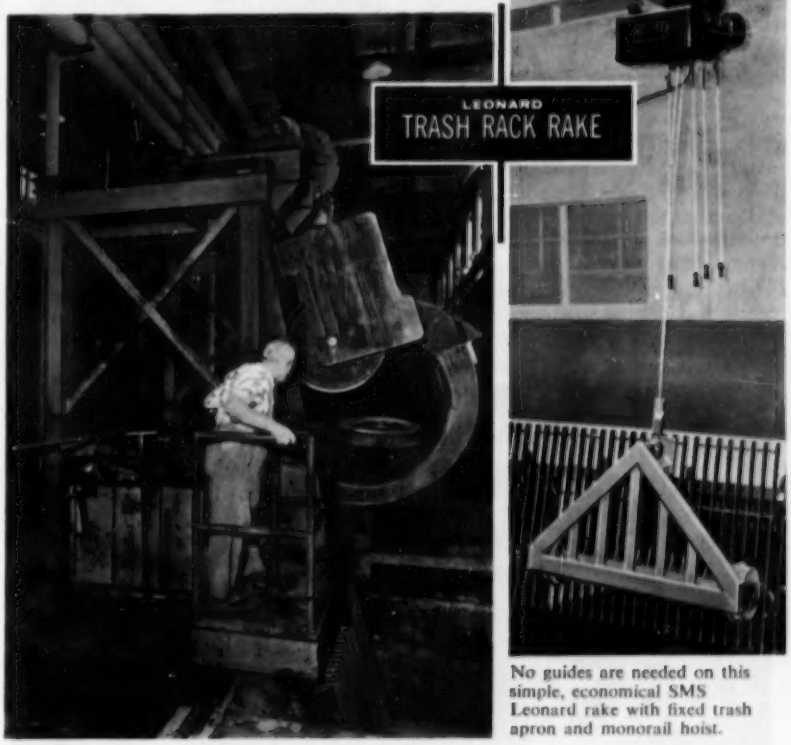
1104

Builders-Providence, Inc., Providence, R. I., has developed the "Pneumaster," Filter Control System. This system combines effluent and wash water controllers, butterfly tight-closing valves, control consoles and all necessary instrumentation.

The Pneumaster filter control system presents the following advantages for the operation of the modern water treatment plant; undivided responsibility; lower cost since tight-closing effluent valves eliminate the need for separate effluent valves; minimum maintenance resulting from the use of non-corrosive components; manual, remote, or master control of all filtration rates as well as superseding or master control from clearwell of influent flume level all as a result of flexible design; low head loss with Venturi measuring sec-

(Continued on page 96A)

7-foot, log-grapple type rake, with hoist support and separate trash car clears debris from a bar screen.



No guides are needed on this simple, economical SMS Leonard rake with fixed trash apron and monorail hoist.

INCREASE PUMP EFFICIENCIES WITH CLEAN INTAKES

Getting more out of existing equipment may be the most economical answer to the increasing demands on water and sewage systems. By cleaning intake racks with SMS rakes, pumping heads are reduced and overall station efficiencies are improved.

SMS Leonard rakes operate directly on trash rack bars . . . ride down over stubborn obstructions and work them loose. Such freedom of movement assures fast, easy cleaning. Initial costs are low because the width of SMS rakes can be kept to the minimum required for handling the trash and the expense of guides attached to racks, or embedded in piers is eliminated. These rakes are of simple and rugged construction, designed for outdoor service and require minimum maintenance.

For information on SMS trash rack rakes and other hydraulic accessories, contact S. Morgan Smith Company, York, Pennsylvania.

HYDRAULIC TURBINES · GATES & HOISTS · TRASH RAKES · PUMPS · ACCESSORIES

HYDRODYNAMICS

ROTOVALVES · FREE-DISCHARGE VALVES · BALL VALVES · CONTROLLABLE-PITCH SHIP PROPELLERS · BUTTERFLY VALVES

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED • TORONTO

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tion; and overload protection for transmitters and control units prevents damage from abnormally high differentials.

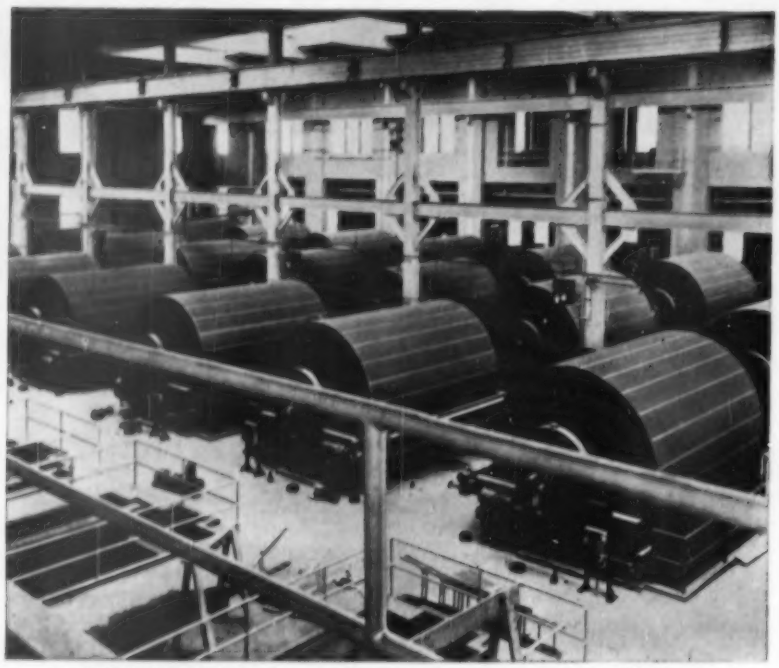
Protective Coating Trial Kit

1105

The Pennsylvania Salt Manufacturing Company's Corrosion Engineering Dept., Philadelphia, Pa., has announced the availability of a low cost trial kit of Thick-Coat, its new resin coating product for humid and corrosive atmospheres. This kit, designed for testing purposes, contains two quarts of Thick-Coat, one quart of Pennsalt Lock Prime, a quart of Pennpaint thinner, complete specifications and directions for use.

The Thick-Coat system provides a durable protective coating for new or corroded metal, concrete and wood surfaces exposed to fumes, corrosive atmospheres and spillage of destructive chemicals.

Thick-Coat has excellent flow qualities and is applied like regular maintenance paint by brush, roller or spray as it comes from the can. Thick-Coat is regularly offered in white, green, slate gray, silver gray, and black and may be obtained in other colors on special order.



Get higher efficiency from your vacuum filters with Pennsalt Ferric Chloride

Pennsalt Ferric Chloride provides *maximum* coagulating and flocculating action for dewatering sludge by vacuum filtration. This *more effective* action reduces the load on your filters . . . increases the yield per filter . . . holds filter downtime to a minimum . . . gives you a drier, easier-to-handle cake.

Whether you run a large plant or a small community operation, it pays to use Pennsalt Ferric Chloride. It is available in two easy-to-use forms: anhydrous $FeCl_3$ in drums, or a concentrated aqueous solution in tank cars. For further information on Ferric Chloride and its use in conditioning sewage, call our nearest District Office. Or write: Pennsylvania Salt Manufacturing Co., Industrial Chemicals Division, Three Penn Center Plaza, Philadelphia 2, Pa.

OTHER PENNSALT CHEMICALS FOR WATER AND SEWAGE TREATMENT: Alum, chlorine, chlorinated lime, Perchloron® (high-test calcium hypochlorite).

Pennsalt District Offices
Appleton, Wis.—Appleton 3-9307
Decatur, Ga.—Evergreen 9690
Chicago 1, Ill.—Andover 3-6170
Cincinnati 2, Ohio—Main 1-3168
Cleveland 15, Ohio—Main 1-6205
Detroit 26, Mich.—Woodward 1-8051
Paterson 1, N. J.—Lambert 5-3500
Philadelphia 2, Pa.—LOcust 4-4700
Pittsburgh 19, Pa.—Atlantic 1-5233
St. Louis 1, Mo.—Central 1-2338
Tacoma 2, Wash.—Market 9101

Pennsalt Chemicals

PENNSYLVANIA SALT MANUFACTURING COMPANY

Chlorine Solution Flow Indicator

1106

Fischer & Porter Co., Hatboro, Pa., has announced the development of a new low-cost, low-maintenance indicator for measuring flows of chlorine solution through lines from two to six inches in diameter.

According to the company, this is the first chlorine solution indicator with an operating principle based on an orifice with a by-pass line. It has a wide ten-to-one range with sufficient accuracy for virutally every application for main line measurement of chlorine solution flow.

Ruggedly constructed throughout of materials which are completely resistant to chlorine solution, the indicator withstands working pressures up to 100 psi (gauge).

The scale reading opposite the glass-ball float in the metering tube—a variable-area meter—directly indicates the main line flow rate. The standard unit creates a pressure drop of 50 inches water at maximum flow.

Plastic Drain Lines Installed By Dallas Plant

1107

Southwestern Plastic Pipe Co., Mineral Wells, Texas, has announced that the installation of plastic pipe as chemical drain lines has been completed for the Purification Div. of the Dallas, Texas Water Department. The plastic pipe is being used to carry chemicals such as ferric iron, lime and chlorine gas in water solution.

According to the company, four and two inch heavy wall kralastic pipe was used, and one of the maintenance features was the installation of "drain plugs" installed in the lines for easy cleaning and "flooding".

Portable Generator Modified For Welding Service

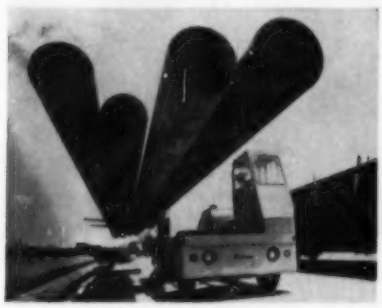
1108

D. W. Onan & Sons Inc., Minneapolis, Minnesota, has announced the development of a new, light-

weight, 2500-watt electric generating plant, designed with special external modifications to operate any transformer type AC welder up to 150 ampere rating.

External modifications of this standard portable electric plant include a convenient 3-pole receptacle for quick plug-in of any transformer type AC welder. With this compact portable source of power an operator may weld anywhere, operate tools or lights and at the same time have available a supply of emergency power whenever commercial power is interrupted.

Self-Loading Truck



1109

Baker-Raulang Company, Cleveland, Ohio, has developed the Traveloader, an industrial truck that can load itself.

By combining the abilities of several different types of equipment, this truck is able to handle long loads like pipe, lumber, steel, etc., with less men and equipment.

The Traveloader stacks up to 12 feet, like a fork truck; carries its loads lengthwise, like a straddle carrier; and delivers with the speed and roadability of a highway truck.

Adjustable Speed Drive

1110

Electric Machinery Mfg. Co., Minneapolis, Minn., has developed the "Ampli-Speed," a precise adjustable speed drive that is easy to handle, install and operate.

The new unit can be coupled or belted to an existing motor to provide a speed control of plus-or-minus two percent for fans, centrifugal pumps and compressors, and is also designed to handle constant torque loads. With this unit, the user can operate a load at the optimum speed; can change speed smoothly by means of a knob, or can control output of

(Continued on page 98A)

The THORO System of Masonry Protection

THOROCLEAR

Invisible Water Repellent

Ask your dealer about this powerful silicone water repellent developed by years of research by General Electric Company and now produced by us for your protection. *Ask for Circulars No. 30 and 31.*

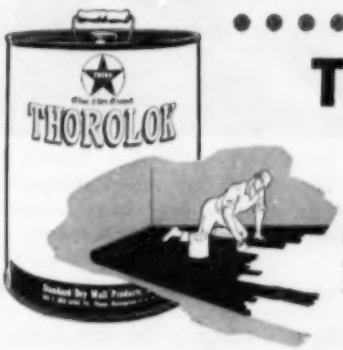
No change in color or texture of brick, limestone, sandstone, tile or stucco surfaces. Applied by brush or spray.

Keep water out of your masonry walls and protect interior plaster, paints and expensive furnishings.

THORITE

20 Minute Set Patching Compound

Repair those broken sills, steps, concrete floors, chimneys and other defective masonry! *Ask for circular No. 20.*



THOROLOK NO. 100

Use it for your basement or factory floors. New, with special alkali resistant pigments. *Ask for Color Card 32-C.*

Manufacturers of

WATERPLUG, THOROSEAL, QUICKSEAL

for all types of masonry protection!

GET OUR PICTORIALLY DESCRIBED LITERATURE "HOW TO DO IT"

STANDARD DRY WALL PRODUCTS, INC.
NEW EAGLE, PENNSYLVANIA

fans, pumps and compressors automatically and with a high degree of precision; can increase efficiency of fan and pump drives, decrease wear of moving parts, and eliminate shocks between the motor and load.

New Roto-Bin-Dicator

1111

The Bin-Dicator Company, Detroit, Mich., has developed a new paddle-type bin level indicator for special installations.

The new unit, called the Roto-Bin-Dicator, is particularly adaptable to installations in bins under pressure or vacuum; bins, chutes or conveyors handling materials containing large lumps which tend to "bridge" over a diaphragm; and bins handling materials which tend to "rat-hole" and prevent operation of a diaphragm.

To circumvent these problems, the Roto-Bin-Dicator has a slowly rotating paddle, mounted on a flexible shaft. This projects into the bin and is driven by a small motor mounted in a housing outside the bin.

When material in the bin partially or entirely covers the paddle, the rotation of the paddle is stopped and the torque exerted by the motor actuates a micro-switch in the motor housing. When material drops below the paddle, rotation is resumed and the micro-switch returns to normal position.

Hardinge CLARIFIERS for rectangular tanks

Three Hardinge primary clarifier units in 22′ x 68′ x 17′ tanks at the municipal sewage disposal plant in York, Pennsylvania. Other Hardinge equipment in this plant—final clarifiers, sludge thickener and digesters. (Albright & Friel, Consultants)

Hardinge has installed more than 70 rectangular clarifier units for municipal sewage treatment, oil refinery wastes and miscellaneous industrial liquid wastes—processing in excess of 300 million gallons of liquid daily.

Complete specifications for all types and sizes upon request. Bulletin 35-D- 15.

HARDINGE
COMPANY, INCORPORATED

YORK, PENNSYLVANIA • 240 Arch St. • Main Office and Works

New York • Toronto • Chicago • Hibbing • Houston • Salt Lake City • San Francisco

"Push-Button" Filter Operating Table

1112

Fischer & Porter Co., Hatboro, Pa., has introduced a new "push-button" waterworks filter operating table which combines high accuracy with low initial cost and minimum maintenance.

The filter table is pneumatically and electrically operated throughout, eliminating mercury cylinders and mechanically actuated devices.

The backwash cycle to clean the filter bed is controlled by a series of five sets of two push buttons arranged in logical operating sequence on top of the console. Only four sets are used if surface wash is not needed. One button in a set opens a valve; the other one closes it. Whether a valve is open or closed is indicated by yellow and blue lights above each set of buttons.

The buttons operate solenoid valves which in turn operate tight closing butterfly type valves in the water line. Three indicators mounted on the filter table show (1) loss of head, (2) rate of flow of raw water, and (3) rate of flow of wash water. In addition, a flashing red signal on top of the table warns when loss of head is such that the filter bed should be cleaned by backwashing.

Floor Protection

1113

Maintenance, Inc., Wooster, Ohio, has developed a new method of protecting concrete, bituminous, mastic

or other industrial floors against acids, water, and cutting oil damage.

The new method consists of simply applying a seal coat of liquid Jennite J-16 over the exposed floors. This can be accomplished by either brush, spray or squeegee at the rate of one gallon per 100 sq. ft. While two coats are said to give adequate protection, three applications are recommended in extreme cases.

The final coat should be allowed to cure eight hours before use. If an abrasive surface is desired, this can be obtained by incorporation of silica sand into the top coat.

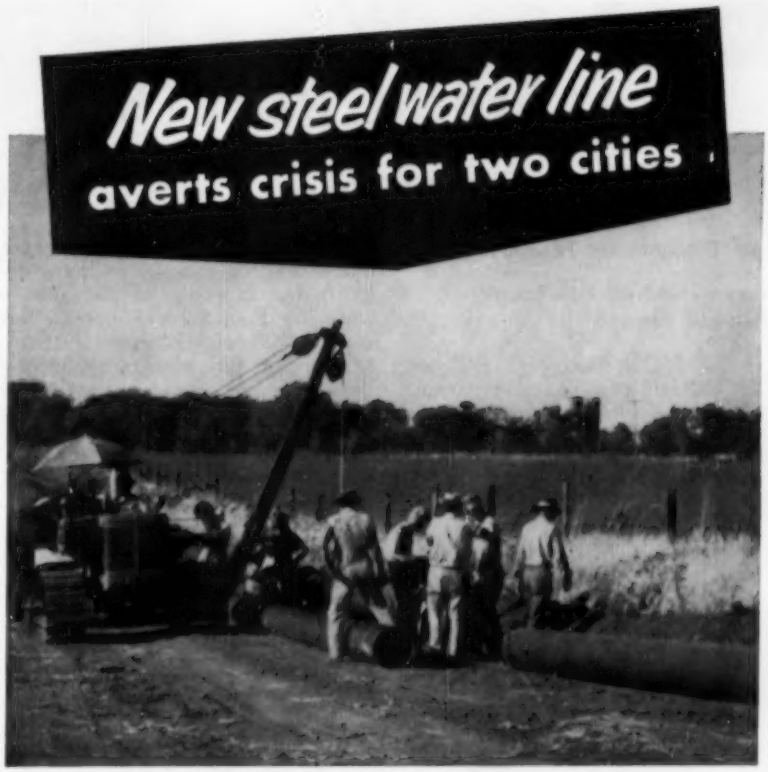
Ultrasonic Flowmeter

1114

Fischer & Porter Company, Hatboro, Pa., has developed a successful ultrasonic flowmeter which will accurately measure either mass or volume flow of virtually any fluid regardless of its electrical conductivity and without being affected by accompanying variables.

The pressure drop of the new flowmeter is virtually zero. Built into a short pipe section, it has no restrictions or moving parts to obstruct flow or cause clogging. The rate of volume flow is measured by two transducers, each of which transmits and receives controlled pulses of ultrasonic energy across the pipe section—one diagonally upstream and the other diagonally downstream—sensing the difference in the number of pulses received. An increasing flow rate increases the number of downstream pulses and decreases the number of upstream pulses. The repetition rate of these pulses cancels out sonic velocity by heterodyne techniques, leaving only the difference in repetition rate which is proportional to flow velocity. This system eliminates entirely the effect of temperature and density on sonic velocity so that flow measurement is unaffected by these two variables.

Variations due to pressure, viscosity, gas bubbles, solids in suspension, electrical conductivity or position of installation are also eliminated in the new flowmeter.



...coated and laid in 30 days!

In 1954, Augusta and El Dorado, Kansas, were hard hit by a prolonged drought. The water-supply situation was so serious that one of the major oil refineries was faced with the prospect of shutting down. There was a chance that other shutdowns would follow. To avert this crisis, the two cities and three oil refineries entered a joint venture and constructed a 32-mile pipeline from Mulvane, Kansas.

This pipeline had to be built quickly. It was coated and laid in a record 30 days, thanks to the use of steel pipe and Bitumastic® Enamels. The lighter weight of steel pipe makes handling easier and permits lighter, speedier equipment to be used. Steel pipe also requires narrower trenches, thus reducing the amount of earth handled in excavating and backfilling.

Bitumastic Enamel was chosen to coat this vital pipeline because it can be applied quickly and, more important, because it provides *lasting* protection against rust, corrosion and tuberculation. Strong steel pipe, protected by Bitumastic Enamel, is an unbeatable combination for your water lines. Write for full information.

SEWAGE EQUIPMENT PROTECTION!

Koppers also makes Bitumastic® Protective Coatings for all kinds of sewage-plant equipment. Give your expensive equipment the effective protection it deserves. Write for complete data.

MADE ONLY BY KOPPERS
KOPPERS® BITUMASTIC® ENAMELS

KOPPERS COMPANY, INC., Tar Products Division
Dept. 1161-T, Pittsburgh 19, Pennsylvania
DISTRICT OFFICES: BOSTON, CHICAGO, LOS ANGELES, NEW YORK, PITTSBURGH, AND WOODWARD, ALA.
KOPPERS PRODUCTS LIMITED · *District Offices: Toronto & Edmonton*

W&SW

Manufacturers' News

B-I-F Discontinues Foundry

Warren Foundry & Pipe Takes Over B-I-F Patterns

B-I-F Industries, Inc., Providence, R. I., stated in a recent announcement: "In our continuing effort to improve our overall operations, we have decided that it would be advisable to close our Foundry and increase our concentration on the design and manufacture of our principal products—those sold by Builders-Providence, Inc., Proportioneers, Inc., and Omega Machine Company. Thus we will no longer manufacture water pipe fittings as we have been doing for many years."

It was also announced that the company's patterns for water pipe fittings had been sold to the Warren Foundry and Pipe Corporation. Warren Foundry and Pipe Corporation has a Boston office and will maintain a stock of fittings at their Everett, Massachusetts, plant.

a summer problem will be no problem

if you call in National now!

If last summer's peak demands created low pressure problems in your water distribution system call National for a *free survey* on how water main cleaning will uprate your system.

You'll find as have other leading communities that National cleaning is an investment—not an expense. National cleaning is so effective that *restoration of at least 95%* of the original capacity of your mains is guaranteed!

Charges are modest with little if any interruption to service. So, for compliments instead of complaints why not call National right now?

Call in National today!

NATIONAL WATER MAIN CLEANING COMPANY
50 Church Street • New York, N. Y.

ATLANTA, GA; 333 Candler Building • BERKELEY, CALIF; 905 Grayson Street • DECATUR, GA; P. O. Box 385 • BOSTON, MASS; 115 Peterboro Street • CHICAGO; 122 So. Michigan Avenue ERIE, PA; 439 E. 6th Street • FLANDREAU, S.D.; 315 N. Crescent Street • KANSAS CITY, MO; 406 Merchandise Mart and 2201 Grand Avenue • LITTLE FALLS, N.J.; BOX 91 • LOS ANGELES; 5075 Santa Fe Avenue • MINNEAPOLIS, MINN; 200 Lumber Exchange Building • RICHMOND, VA; 210 E. Franklin Street • SALT LAKE CITY; 149-151 W. Second South Street • SIGNAL MOUNTAIN, TENNESSEE; 204 Slayton Street • MONTREAL, CANADA; 2032 Union Avenue • WINNIPEG, CANADA; 576 Wall Street •. HAVANA, CUBA; Lawrence H. Daniels, P.O. Box 531 • SAN JUAN, PUERTO RICO; Luis F. Caratini, Apartado 2184.

Clow & Sons Add Payne Dean Operators To Line

James B. Clow and Sons, Inc., Chicago, Ill., and its subsidiaries, the Eddy and Iowa Valve Companies, have been named exclusive distributors of Payne Dean powered Valve Operating Equipment.

Addition of the Payne Dean line gives Clow a complete package of valve operating equipment which supplements its regular products of pipe, valves, fittings, and waterworks supplies.

Bailey Meter Names Duensing To Head Water & Waste Division

Bailey Meter Company, Cleveland, Ohio, has announced that R. W. Duensing, formerly of the Chicago district office, has been named to direct the company's Water & Waste Treatment Division.

Graduated from the University of Illinois in 1948, with bachelor of science degrees in electrical and civil engineering, Duensing joined the company at that time. Prior to working in the Chicago office, he worked in the contract engineering department at the company's Cleveland main office and in the Kansas City office.

Dr. Frame Joins F. S. Gibbs

F. S. Gibbs, Inc., Newton Lower Falls, Mass., has announced the ap-

pointment of Dr. John D. Frame to the Sales Engineering staff.

Dr. Frame obtained his B. S. in Civil Engineering at Norwich University, his Master of Science and Doctor of Science, both in Sanitary Engineering, at Mass. Inst. of Technology. Since 1951 Dr. Frame has been Research and Project engineer for Metcalf and Eddy, consulting engineers in Boston.

Dr. Frame will work in the field on the Gibbs Flotation Units as applied to sanitary and industrial uses, and will direct a laboratory for the testing of samples submitted.

S. Morgan Smith Promotes Two

S. Morgan Smith Company, York, Pa., has announced two executive promotions.

Oscar E. Weber, former Director of Purchases for the company, has been made Production Co-ordinator, and Otto H. Koerner, formerly a sales engineer in the Turbine Sales Division, has been named Director of Purchasing.

In his new capacity as Production chief, Weber will be charged with maintaining schedules among all divisions of the company. He has been with S. Morgan Smith since 1932. Koerner joined the company in 1941.

Armco Drainage Advances Four

Armco Drainage & Metal Products, Inc., Middletown, Ohio, has announced the following four executive appointments:

William O. Robertson has been named vice president in charge of sales for the company. He has been vice president and manager of the eastern division of the company.

Tom M. Neibling, former vice president and manager of the company's southwestern division, has assumed the same position in the eastern division.

W. W. Mains, vice president and manager of the Missouri-Kansas division in the past, has been appointed vice president and manager of the southwestern division.

A. J. Mistler has been named division manager of the Missouri-Kansas division. He has been division sales manager.

Graver Appoints New Representative

Graver Water Conditioning Co., New York, N. Y., has announced the appointment of the Edward G.

(Continued on page 102A)

TO HELP CONSERVE YOUR WATER SUPPLY

WATER is becoming more scarce, more expensive to obtain, treat, pump and deliver.

CONSERVATION starts with the efficient handling and delivery of water supplies — including meters, meter setting and testing equipment.

THE new Ford Catalog No. 56 is a water man's "bible". It not only pictures and lists the latest in meter servicing equipment, but it contains diagrams and much helpful data for the express purpose of conserving water through more efficient use of meters. It is available on request. Send for your copy today.

FORD FOR BETTER WATER SERVICES

THE FORD METER BOX COMPANY, INC. Wabash, Indiana

HYDRO-TITE

DEPENDABLE JOINTING COMPOUND

Seals Bell and Spigot Water Mains

Economical—Effective

Over 35 Years Of Dependable Performance

HYDRAULIC DEVELOPMENT CORP.

MAIN SALES OFFICE 50 CHURCH ST., N. Y. C.

General offices and works W. Medford Sta., Boston, Mass.

Moninger Co. as Graver's representatives in Minnesota, North Dakota, South Dakota, and northwestern Wisconsin.

The Edward G. Moninger Co., located at 504 Plymouth Building, Minneapolis 3, Minn., will handle Graver's complete line of industrial and municipal water treatment and industrial waste treatment equipment.

Koehring Names Burton Ass't Sales Manager

Koehring Co., Milwaukee, Wis., has announced the appointment of R. E. Burton to the position of Assistant General Sales Manager. In his new post, Burton succeeds M. O. Messenger who recently was named Vice President and Sales Manager for Koehring's Canadian subsidiary, Koehring-Waterous Ltd., in Brantford, Ontario.

Burton has been associated with the Koehring organization since 1948. He started his career at the C. S. Johnson Company, a Koehring subsidiary located in Champaign, Illinois, where he worked as a draftsman and as a sales engineer. In 1952 he became the Koehring Company foreign representative to its subsidiary, Ishikawajima-Koehring Ltd., located in Tokyo, Japan.

Kuhn Promoted By Hills-McCanna

Hills-McCanna Company, Chicago, Ill., has announced the appointment of Charles Kuhn as Sales Manager of the Products Division of that company.

In this capacity, Mr. Kuhn will be responsible for sales of Hills-McCanna Saunders Patent Diaphragm Valves, Chemical Proportioning Pumps and Force Feed Lubricators.

Mr. Kuhn was formerly Vice-President in Charge of Sales of the Fansteel Metallurgical Corporation of North Chicago, Illinois.

Walters Joins Infilco

Infilco Inc., Tucson, Arizona, has announced the appointment of John G. Walters to the position of Infilco Sales Representative for Georgia, North Carolina and South Carolina.

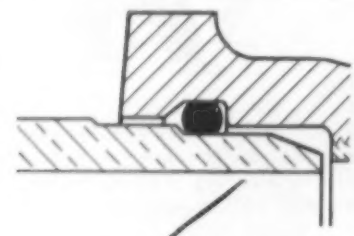
Mr. Walters has a Bachelor of Science Degree in Chemistry and Biology from Washington College, Chestertown, Md., and a Master of Arts Degree from Teachers College of Columbia University. He took pre-med courses at Temple University School of Medicine and studied a year at Johns Hopkins, Dept. of Sanitary Engineering.

After two years in the Army Mr. Walters became the first field representative for the Maryland Water Pollution Control Commission, where he served from 1947 to 1951. From 1951 until joining Infilco in 1953 he served industry as a consultant on waste disposal.

Rumery Joins Byron Jackson

Byron Jackson Division of Borg-Warner, Los Angeles, Calif., has announced the appointment of John W. Rumery to head its business development program.

For the past several years, Mr. Rumery has been engaged in the investment management business in southern California. His assignment with the company will be "to constantly explore the industrial community of this area for firms seeking additional financing, engineering help



RING-TITE JOINT

VALVES & HYDRANTS FOR

RING-TITE ASBESTOS-CEMENT PIPE LINES

M H

For installing M&H Valves and Hydrants in a Ring-Tite asbestos-cement pipe line, specify valves or hydrants with Ring-Tite end connections. The connecting ends of the valve or hydrant are especially designed to enclose a round rubber ring gasket when the end of Class 150 Ring-Tite pipe is inserted, as illustrated in sketch above.

Installation is easy and simple. Unskilled workmen can make up the connection quickly and economically. No special fittings nor extra joint materials are required. The joint is tight against low or high pressure. For full information, wire or write

M & H VALVE AND FITTINGS COMPANY, ANNISTON, ALABAMA

M&H PRODUCTS FOR WATER WORKS • FILTER PLANTS INDUSTRY • SEWAGE DISPOSAL AND FIRE PROTECTION

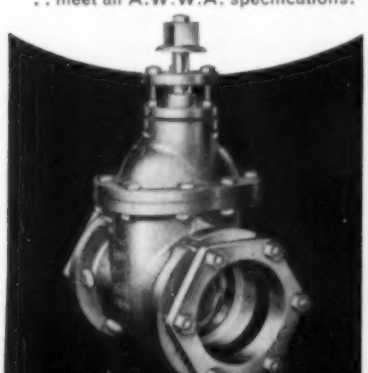
Remember:
the VALVES you buy today may have to be maintained by your GRANDCHILDREN!

Specify
IOWA because...

you can always count on Iowa for a lasting source of replacement parts . . . and products that service easily.

Look for These Features:

Double disc, parallel seat . . . positive wedging action for efficient, no-leak closing . . . gates hung loosely from stem nut—no binding . . . rugged, time-proved design means long life, low service costs . . . available with bell, flange, or mechanical joint connections to fit any existing or planned installation . . meet all A.W.W.A. specifications.



IOWA gate valves . . . for details, phone, wire or write:

IOWA
VALVE COMPANY
A subsidiary of James B. Clow & Sons
201-299 N. Talman Ave., Chicago 80, Ill.

or production facilities which Byron Jackson could furnish to provide extra growth opportunities for both organizations."

Sales Appointments At Allis-Chalmers

Allis-Chalmers Manufacturing Co., Industries Group, Milwaukee, Wis., has announced new appointments in their sales organization.

V. L. Spinney, Manager of the New York district since 1949, has been named manager of the central region succeeding R. L. Halsted, who was recently appointed manager of the firm's processing machinery department. Spinney's new headquarters are in Cleveland.

N. W. Landis has been named manager of the New York district succeeding Spinney. Landis had been manager of the Detroit district since 1950.

A. J. Mestier, Jr., for the last five years manager of the Syracuse district, succeeds Landis as manager at Detroit.

Cross Joins Straitsville Brick Co.

The Straitsville Brick Co., New Straitsville, Ohio, has announced the appointment of James A. Cross as representative for design engineering for the company's Ceramifilter Floor, a two-piece floor for trickling filters.

Mr. Cross is also serving the company as sales engineer and factory representative, with offices in Pottstown, Pa.

A graduate of Ohio State University with a bachelor degree in ceramic engineering, Cross has been associated with the Universal Sewer Pipe Corp., the Robinson Clay Product Co., as a ceramic engineer, and with Industrial Materials Co., as sales engineer with emphasis on trickling filter floors.

Neptune Meter Appoints Two Sales Representatives

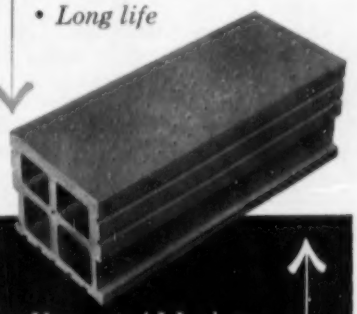
Neptune Meter Co., New York, N. Y., has announced the appointment of John J. Moran and Bill L. Sidebotham as sales representatives.

Mr. Moran, of Franklin Square, N. Y., will join James L. Wheelin in contacting municipal and privately operated water systems in the New York metropolitan area.

Mr. Sidebotham of San Bruno, Calif., will be charged with the distribution of water meters to municipal and privately operated water sup-

(Continued on page 104A)

- *Permanence*
- *No tuberculation*
- *Equal distribution*
- *Uniform filtration*
- *Low loss of head*
- *Acid, alkali-resistant*
- *Long life*



You get ALL these advantages with
LEOPOLD
Glazed Fire Clay
TILE FILTER BOTTOMS

Today, in more than 250 plants with a daily capacity of over 1¼ billion gallons, Leopold Duplex Filter Bottoms are providing dependable, economical service with minimum maintenance.

Made of highest quality de-aired fire clay—vitrified and salt glazed, the Leopold Filter Bottom requires only a shallow depth of small sized, inexpensive filter gravel to support the filtering medium. Further, the laterals and distributing blocks are all combined in one strong permanent unit that will last indefinitely.

Adaptable to any rectangular filter unit, the Leopold Glazed Tile Filter Bottom is designed to successfully meet all underdrain requirements.

Each Leopold filter block is about 2 sq. ft. in area—weighs approximately 100 pounds.

Complete Water Purification and Sewage Plant Equipment . . .

- **DRY CHEMICAL FEEDERS**
- **FILTER OPERATING TABLES**
- **MIXING EQUIPMENT**

Want more details? Write us today.

F. B. Leopold Co., Inc.
2413 W. Carson Street
Pittsburgh 4, Pa.

ply systems in Central and Northern California.

Armco to Start Pipe Coating Plant

Armco Steel Corporation, Middletown, Ohio, has announced that it will convert the recently purchased Middletown facilities of Warren Steel Corporation into a modern pipe coating plant.

The company stated that about $360,000 will be spent to move the present pipe coating operation to the new plant and to install necessary equipment and facilities. New machinery for coating Armco welded-steel pipe with coal tar enamel will include abrasive cleaning equipment, a unit to line the inside of the pipe, and a wrapping machine which coats the outside of the pipe and wraps it with a protective material.

Alabama Pipe Plans Plant Improvement Program

Alabama Pipe Co., Anniston, Ala., has announced plans for a $2,500,000 improvement program at their Union Foundry.

In place of the old building, there will be erected a steel and protected-metal building of modern design with floor space of 80,000 sq. ft. and a clear span of 138 feet. The roof will be provided with two panels of corrugated glass on each side for illumination and power ventilation will change the air in the building completely every 3 minutes.

Concurrently with the foundation on the new building, work will be started on foundations for centrifugal pipe casting equipment, a second step in a program started in 1948 to cast all pipe products by the centrifugal method.

Smith-Scott to Distribute Plastic Pipe

Smith-Scott Co., Inc., Riverside, Calif., has announced the opening of a plastic pipe and fittings division. The company has signed an exclusive sales agent agreement with Kerr Industries to take their entire factory production of rigid Polyvinyl chloride pipe.

Smith-Scott is now in the process of setting up distributors and dealers. Many of its present steel pipe dealers will handle the plastic pipe and fittings. The new rigid plastic pipe comes in standard 20-foot lengths and is reported to have exceptionally high tensile and impact strength.

Peterson Promoted By Brown Instruments

Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Philadelphia, Pa., has announced that C. L. Peterson has been appointed vice president and general manager of the Division.

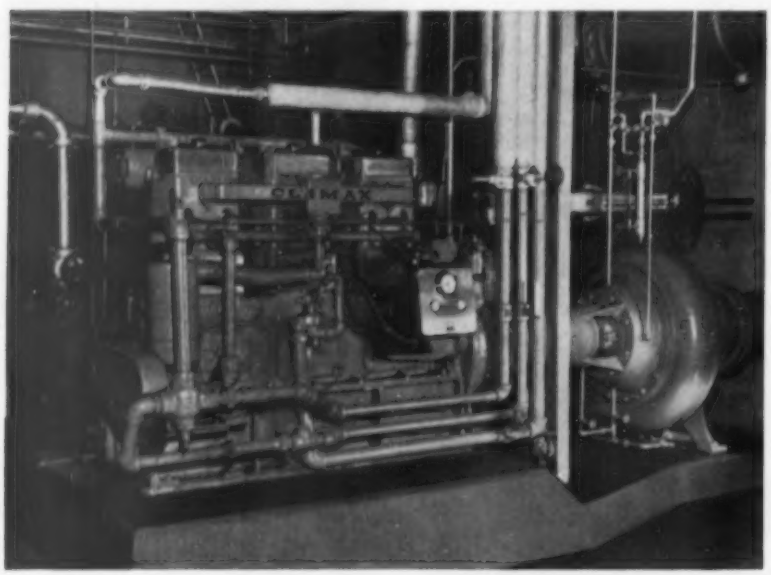
Peterson will be responsible for the direction and coordination of operations in all departments of the Division.

A 28-year man with the firm, Peterson had been general sales manager of the Brown Instruments Division until his appointment as divisional vice president. Before that he had been regional manager for Honeywell for the Midwest and also for the Pacific region.

Proctor Elected to Board Of Simplex Valve

The Permutit Company, New York, N. Y., has announced that George N. Proctor, Vice President of the Permutit Company, has been elected a member of the Board of the Simplex Valve & Meter Company, Lancaster, Pa.

Mr. Proctor, associated with both concerns since 1944, was elected Vice President of Simplex Valve & Meter in March, 1950.



FINDLAY, OHIO

A Climax model R61 sewage gas engine direct connected to a horizontal 6 MGD centrifugal pump requiring 50 HP at 490 RPM.

When additions were made recently to the Findlay, Ohio, Sewage Treatment Plant, a Climax engine was selected for continuous operation of the raw sewage pump, due to its proven dependability, economy and low maintenance cost in this type of service.

Additions to plant designed by and construction supervised by Jones, Henry & Williams, Consulting Engineers, Toledo 4, Ohio.

climax

FOR COMPLETE INFORMATION, WRITE TO . . .

ENGINE AND PUMP MFG. CO.

208 So. La Salle St.

CHICAGO 4, ILLINOIS

Factory–Clinton, Ia. *District Office*–Dallas, Tex.

Literature & Catalogs

Micro-Straining Plant

1115

Glenfield & Kennedy, Inc., New York, N. Y., has available a 26-page booklet on the **Micro-Straining Plant** for clarification of potable and industrial water supplies and effluents.

This informative booklet, amply illustrated with photographs and drawings, covers: a basic explanation of Micro-straining; Fundamental considerations—filtrability of fluids; Nature of suspended impurities in water and effluents; Complete description of the Glenfield patent Micro-strainer units; the various applications, Primary clarification, Micro-straining as a complete clarification process, sewage purification, industrial applications, and special applications.

Also a series of case histories of various installations are included. Photographs illustrate each one of these applications.

Water, Waste and Sewage Equipment

1116

Walker Process Equipment Inc., Aurora, Illinois, has just released a new general bulletin containing photographs, drawings, and descriptions of their line of **Water, Waste and Sewage Treatment Equipment.**

The 24-page catalog is attractively printed in two colors and serves as an excellent introduction to this firm's coverage of municipal and industrial treatment processes.

Instrumentation For Water Treatment Plants

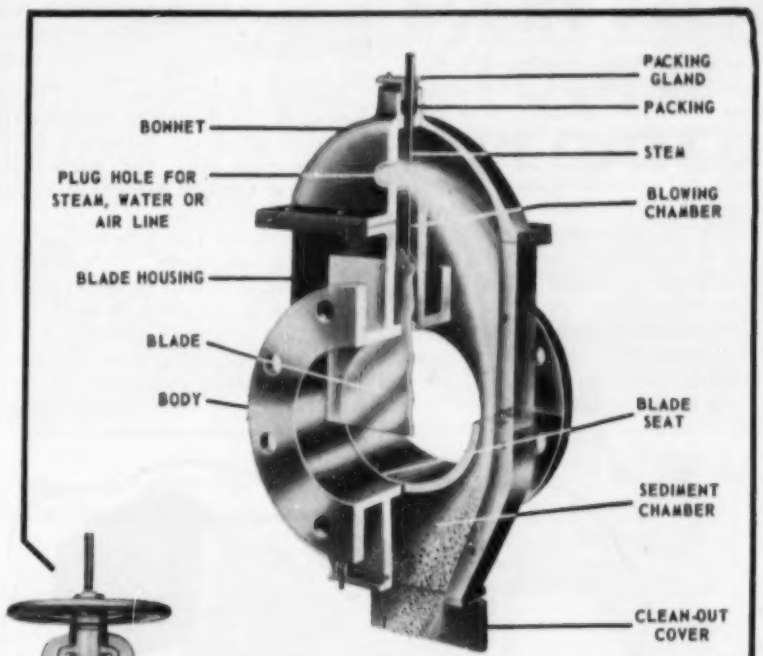
1117

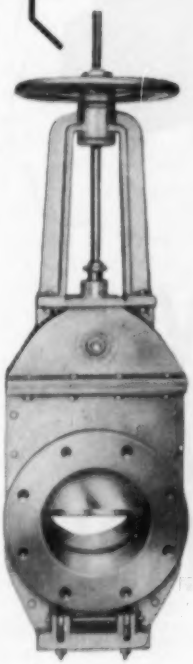
Fischer & Porter Company, Hatboro, Pa., has just issued a brochure describing **Instrument Control For Water Treatment Plants.**

A two-page flow sheet graphically illustrates most of the instrument applications possible in a large municipal water treatment system.

Featured in the 12-page booklet is the new Fischer & Porter filter operating table. The illustrations include a flow diagram showing the F & P system for operation of rapid

(Continued on page 106A)





KWIKLEEN

Heavy Duty

The Valve That's Easy to Clean

without Removing from Pipe Line

The ideal valve for sewage, debris, liquids or gases carrying high percentage of solids. Combines full flow area, minimum pressure drop, quick control and easy, quick cleaning, blowing or washing out, without dismantling.

Write for Bulletin No. 508

W. S. ROCKWELL COMPANY

BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES

2825 ELIOT STREET • FAIRFIELD, CONN.

Sales Representatives in Principal Cities

• **If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.**

sand filters by means of modern instrumentation. Operation of the filter table is described in detail.

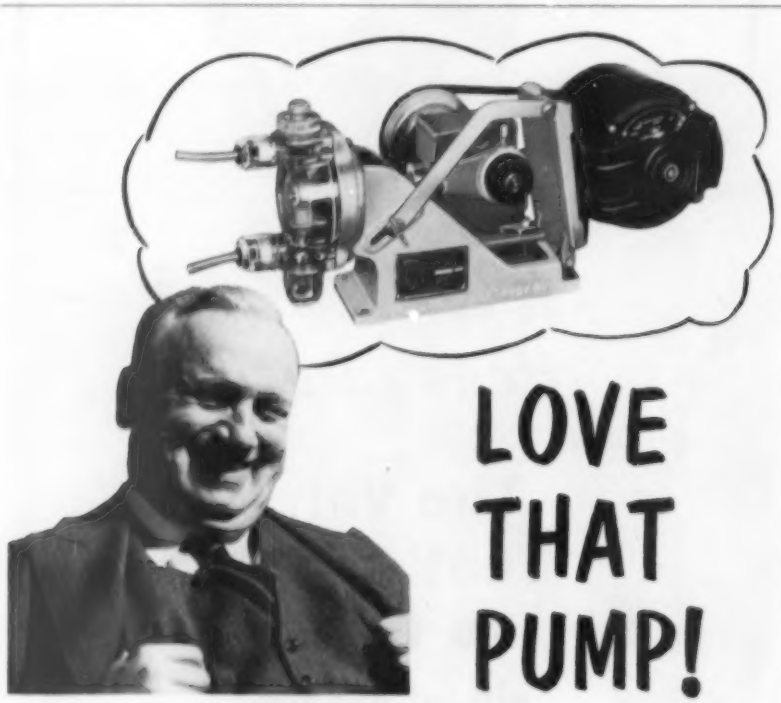
Other instruments described include standard, portable, and automatic proportioning chlorinators, flow meters, residual chlorine analyzers, pH and oxidation-reduction-potential meters, intake screen controllers, thermometers, pressure gauges, complete centralized control panel units, and systems for measurement, recording, control and automatic logging of operating data from filter plants, pumping stations, water supplies and other points in the water system.

Automatic-Centralized Filter Control

1118

Builders-Providence, Inc., Providence, R. I., describes centralized filter operation and automatic filter backwashing with the **Auto-Central Filter Control System** in a four page color bulletin.

The bulletin contains typical installation and product photographs, schematic diagrams of the system's operation in addition to useful information on the description, operation and advantages of the unit. These include reduction in construction costs by centralizing all plant instrumentation and filter supervision, eliminating the need for shelter over conventional operating galleries; reduction in operating expenses since one supervisor controls entire filter plant operation; saves time two ways since automatic backwash cycle relieves attendant for other duties, while high speed wash water recorder eliminates log entries and computations; and improves filter performance by indicating immediately when head loss is excessive and by providing uniform backwashing as well as eliminating faulty operating practices and failures due to human error.



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Jeffrey Products Catalog

1119

The Jeffrey Manufacturing Co., Columbus, Ohio, has available a booklet that gives a quick and concise picture of **Jeffrey Products and Facilities.**

This handy 48-page pocket size booklet by means of photographs and accompanying text shows briefly the complete line of products made by the company. The back page of the booklet gives a list of all the Jeffrey district offices.

Traveling Water Screens

1120

The Jeffrey Manufacturing Co., Sanitation Sales Division, Columbus, Ohio, has just released a bulletin describing **Traveling Water Screens** for use in water treatment plants and power stations.

The bulletin demonstrates how these screens remove destructive floating debris and suspended matter from water by straining them from the influent channel. A drawing, complete specifications and a data form for estimating purposes are included.

Filter Control Console Bulletin

1121

Builders-Providence, Inc., Providence, R. I., has just issued a supplementary bulletin describing their **Pneumaster Console,** the streamlined housing for filter gages, valve-operating switches and valve position indicators, which meets the most exacting needs of the modern filter plant by utilizing precision air receivers and receiver-type filter gages to receive and accurately indicate filter flow and head loss data.

The bulletin contains clear photos

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and descriptive information on the console — a factory-assembled unit with the following advantages: accuracy and sensitivity obtained by use of precision indicating gages; easy, inexpensive installation requiring only a few simple connections; quick report back of actual valve position achieved by precision valve position indicators; functional design of component gages, indicators, controls at convenient height allows operator to "see-over" for back-washing operations; and minimum maintenance by elimination of cables, cords, pulleys and counterweights from the pipe gallery.

Underdrain System For Rapid Sand Filters

1122

Builders-Providence, Inc., Providence, R. I., has just issued a 4-page color bulletin describing the precast and monolithic type **Wheeler Filter Bottom** underdrain system for rapid sand filters.

The bulletin contains typical installation and construction photographs of the system, which consists of conventional layers of sand and gravel placed over a false concrete bottom supported by piers. Inverted pyramidal depressions uniformly spaced, contain specially proportioned, porcelain spheres and orifices at the bottom through which the water flows.

Reference Bulletin On Sewage Treatment

1123

Precision Scientific Company, Chicago, Ill., has published **Bulletin 240** as a reference manual for sanitary and public works engineers and chemists, public health officers, municipal officials, private industry, and local, state and federal agencies interested in the proper disposal of sewage and industrial wastes.

The 8-page bulletin contains a a complete listing of apparatus used for the testing and control of sewage effluent by American Public Health Association methods. Also included is a listing of the apparatus available from this manufacturer.

Tylox Flexible Couplings

1124

Universal Sewer Pipe Corporation, Cleveland, Ohio has released a new, fully illustrated brochure

(Continued on page 108A)

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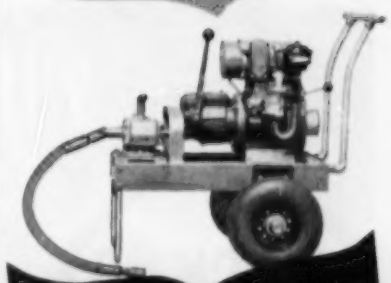

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containing complete descriptive information and installation data on Universal Vitrified Clay Pipe with Pre-assembled **Tylox Flexible Couplings.**

Of special interest to engineers, contractors, municipal officials and others concerned with planning and building sewerage and drainage systems, the brochure gives complete information on Universal's Rubber, Neoprene and Polyvinyl Chloride resin type of Tylox Couplings, and recommends where each type should be used.

Tylox Couplings are a multiple-ring sealing type, factory applied compression Gasket, which are cast integral with the pipe socket by special manufacturing processes developed by Universal Sewer Pipe Corporation.

Vertical Turbine Pumps

1125

Layne & Bowler Pump Company, Los Angeles, Calif., has just issued a bulletin on **Verti-Line Primary Water Supply Pumps.**

Sectional illustrations with enlarged views of special features clearly describe the products. Detailed drawings of pumping and distribution systems are also included. A condensed selection table is a valuable guide to horsepower, head and capacity ratings of Verti-Line pumps.

Corrosion-Protection Tape

1126

Tapecoat Company, Evanston, Illinois, has just published a brochure on how to get greater coverage from protective coating at lower costs in safeguarding pipe, pipe joints, fittings and couplings by using **Tapecoat-X.**

The brochure covers the complete story on Tapecoat-X, a new coal tar coating in tape form which is made with an extra thickness of coal tar to provide double-wrap protection from single-wrap application. Included in the booklet, is a table of coverage which shows how the new product goes farther and reduces costs on time, labor and material.

Dissolved Oxygen Analyzer

1127

Arnold O. Beckman, Inc., South Pasadena, Calif., has just compiled and published a new technical bulletin on the application of the Beckman Model 2B2B **Dissolved Oxygen Analyzer.**

Data covered includes basic principles of measurement, equipment required, flow diagrams and descriptions of typical sampling systems for various types of plant setups, a flow diagram and detail illustrations of the Analyzer itself, benefits and savings that result, and other helpful technical information of particular interest to fact-seeking power plant personnel.

Accurate Lime Feeding And Complete Slaking

1128

Omega Machine Co., Providence, R. I., has issued a four page color bulletin describing accurate lime feeding and complete slaking with **The Omega Lime Slaker and Feeder.**

The bulletin contains many clear installation and product photographs, descriptive information on dry feeders and lime slakers, and lists such advantages as rapid, thorough slaking with high speed agitation; prevention of overheating due to thermostatic control; vapor removal devices eliminate

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hot, moist vapors; top slaking efficiency assured with standard heat exchangers; volumetric models available where simplicity of installation is required; gravimetric models furnished to compensate for difference in weight per unit of volume.

Pipeline Protection Booklet

1129

Minnesota Mining and Manufacturing Co., St. Paul, Minn., has just published a 16-page, illustrated booklet describing applications and giving property data on "Scotch" brand products for **Pipeline Protection.**

The 2-color booklet covers the use of "Scotchrap" brand all-weather pipe wrap tapes, "Scotchrap" brand pipe primer, and "Scotch" brand filament which is used for attaching rock shields to buried pipe.

Charts showing complete physical and electrical insulating properties for each of the products are included and a wide range of typical pipeline applications are pictured in addition to a brief discussion of each.

In addition the booklet covers "Scotchfil" electrical insulation putty, "Scotch" brand plastic tape, and "Scotchkote" electrical coating for use in protection of splices in anode ground bed installations where resistance to moisture, fungus and mechanical abrasion is required.

Variable Speed Transmissions

1130

Sterling Electric Motors, Inc., Los Angeles, Calif., has released a new bulletin on their **Speed-Trol Variable Speed Transmissions.**

The informative brochure has

(Continued on page 110A)

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sections of interest to both engineers and laymen in its discussion of the inner workings of the Sterling positive pulley design. Also featured is information on factors in drive selection and a description of the many types of automatic and remote speed control accessories available.

Industrial pH Guide

1131

Beckman Instruments, Inc., Fullerton, Calif., has just published the **Industrial pH Buyer's Guide** to enable users of industrial pH instrumentation to simply and easily match components such as meters, flow or immersion assemblies, electrodes and manual or automatic electrode switches.

The 4-page illustrated guide shows pictorially which components replace older units and how older and newer components can be used together. It also includes a cross-reference chart to simplify electrode selection and tells exactly how to order pH equipment.

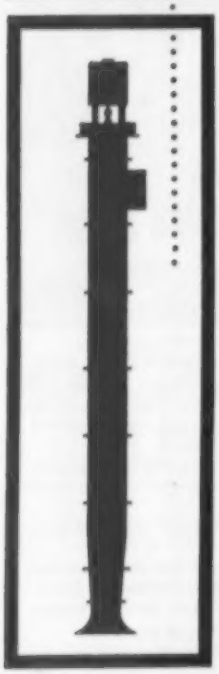
Diesel Electric Sets

1132

Caterpillar Tractor Co., Peoria, Ill., has just published a booklet on **Modern Electric Power.**

The booklet describes how this new line of compact and versatile, small size, high capacity electric sets brings a new concept in generators.

In four illustrated pages, this booklet discusses the advantages of these rugged sets, matched to their Cat engines to provide maximum efficiency.



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To establish water supply from the Mississippi River to the vast area of Bayou La Fourche, required the utmost ingenuity and cooperation between the State of Louisiana engineers and Economy Pumps engineers. Three 42" x 48" Wheeler-Economy AFV Axial Flow Pumps were selected to do the job. Design capacity is 45,000 GPM at 17' TDH. But when these pumps operate as a syphon they move 65,000 GPM. Motors are 250 HP operating at 514 RPM. Pumps in operation run 24 hours a day.

It is believed this is the first application of pumps of this design to pass such a high volume of water on the syphon principle. Infinite care in planning and construction is typified by the exact length each pump had to meet—51'¾" from underside of mounting plate to end of suction bell. Moreover, every increment assembled in the field had to be made airtight by skilled Wheeler-Economy specialists to make possible the necessary vacuum.

Success was largely assured by Wheeler-Economy's extensive manufacturing facilities in Philadelphia. Here, in one of the largest test pits in the industry, witness tests were made by the State of Louisiana and the contractor to prove pump performance before delivery.

You, too, can rely on Wheeler-Economy for help on complex pumping problems, dependable delivery and performance that lives up to promise.

WES-13

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Vertical Hollow Shaft Electric Pump Motors

1133

ACEC Electric Corp., New York, N. Y., has just released a full color bulletin on the company's latest line of **Vertical Hollow Shaft Pump Motors.**

The motors described and pictured in the publication have been developed especially for driving heavy-duty turbine pumps. The booklet explains features of design and construction that enable these motors to operate day after day without supervision, in exposed locations, where maintenance is difficult and downtime costly.

Action drawings explain the operation of a newly-developed ball-type non-reverse ratchet that prevents destructive backspin. Should the motor begin to turn in reverse, the ratchet locks within 1/72 of a revolution and prevents rotation.

Anti-Corrosive Water Treatment

1134

The Permutit Company, New York, N. Y., has announced the availability of an informative catalog sheet on **Preventing Corrosion of Drinking Water Lines.**

The bulletin details a new service which stops "red water troubles" and prevents the destruction of piping, thus reducing maintenance and replacement costs. It is available to industrial buildings, apartment and office buildings, department stores, theaters, in fact any large consumer of water.

According to the catalog sheet this service consists of treating incoming water supplies in order to make them non-corrosive. Chemicals such as one-tenth of a pound of sodium silicate per 1000 gallons are added to the raw water through a chemical feeder mechanism in order to prevent corrosion of lines.

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Squaw Peak Filter Plant

(COMPLETED IN 1954)

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General view of the plant — sedimentation basins in the foreground and Chemical Building at rear center.

Interior view of Chemical Building showing Omega Chemical Feeders and Lime Slakers. C. U. Pollard, Plant Supt., is checking plant operation at the centralized Control Panel at right.

Leon W. Jackson, Resident Engineer for Headman, Ferguson and Carollo, at filter table with Builders Loss-of-Head and Rate-of-Flow Gauges. The main instrument panel shown here and a second "repeater" panel in the Chemical Building meter all major plant functions by means of Builders Chronoflo and Pneumatic Instruments.

When people talk about growth areas of this country, the name Phoenix, Arizona is sure to come up. In the last ten years alone, the population of greater Phoenix has increased by over 200 per cent. Manufacturing today rivals agriculture for the top industry of the state. Everything about Phoenix points to continued municipal growth in the years ahead.

Part of Phoenix's progressive planning is the new Squaw Peak Filter Plant and Reservoir, a $2,069,000 project which now brings the Phoenix water supply to 114 MGD total capacity. The Omega Dry Chemical Feeders in this modern plant were selected with an eye to the future — for their ability to give faithful, accurate service for years to come. For full information on the Omega Feeders and Lime Slakers at Squaw Peak, write Omega Machine Company, Providence 1, Rhode Island.

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W&T Chlorinators with chlorine evaporators and master control panel (insert) used at the D.C. Sewage Treatment Plant.

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